Journal of the Society of Arts.

FRIDAY, DECEMBER 20, 1867.

Announcements by the Council.

Artisans' Reports on the Paris Exhibition.

The Reports of the Artisans selected by the Council to visit the Paris Exhibition are now in the press, and will be published in a few days, by the Society's publishers, Messrs. Bell and Daldy, York-street, Covent-garden. One volume; demy 8vo., price 2s. 6d.

Cantor Lectures.

The first course for the present session is "On Art, especially including the History and Theory of Sculpture," and is being delivered by Richard Westmacott, Esq., R.A., F.R.S., Professor of Sculpture in the Royal Academy, as follows:—

December 20th.—Lecture III.—The subject continued, including a review of the mediæval and more modern schools, to the close of the eighteenth century.

The lectures commence each evening at eight o'clock, and are open to members, each of whom has the privilege of introducing two friends to each lecture.

Technical Education.

The Council feeling the great importance of this subject, have resolved to hold a Conference at the Society's house, on the 23rd and 24th January next, the particulars of which are explained in the following circular:—

Society for the Encouragement of Arts, Manufactures and Commerce, Adelphi, London, W.C.,
9th December, 1867.

Technical Education.

Sir,—I am directed by the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, to invite your (Chamber of Commerce or other body) to appoint its President or other representative, to attend a Conference which is to be held here, on Thursday and Friday, the 23rd and 24th of January next, to consider and suggest what measures may be taken to promote the industrial and scientific education of the various classes of the community.

The Conference will commence its sittings on Thursday, the 23rd of January, 1868. The Chairman of Council will take the chair at 12 o'clock precisely.

At as early a period as possible, the Council will issue to each gentleman who accepts their invitation to the Conference a programme of the probable course of its proceedings; and, to enable the Council to do this in a satisfactory manner, I am to request you to inform me, with the least possible delay, whether a representative from your [ ] will be able to attend the Conference; whether your [ ] has any special resolutions to suggest, or any particular points to which it desires to direct attention; what general measures for the promotion of education it may conceive to be requisite; and what institutions of a specific character are needed in your own neighbourhood to give the greatest practicable facilities for the acquisition of knowledge applicable to your local industries.

The object of the Conference is to ascertain, not merely what the Society of Arts, Manufactures, and Commerce, but what the nation at large can do to promote technical education among the workmen, the foremen, the overlookers, and the employers in Arts, Manufactures, and Commerce; and it is hoped that an expression of opinion by this Conference may tend in some degree to diminish the difficulties with which the solution of this vital question of national education is at present confessedly surrounded.

I am, your obedient servant,
P. Le Neve Foster, Secretary.

The foregoing circular has been forwarded to:—

- The Mayors of the Towns which are the principal seats of manufacture in the United Kingdom.
- The Presidents of the Chambers of Commerce and Agriculture.
- The Presidents of all Societies and City Companies which have co-operated with the Society in respect of Education or Art-workmanship.
- The Presidents of Institutions in Union with the Society of Arts.
- Her Majesty's Inspectors of Schools, Factories, Mines, and Collieries.
- Professors at University, King's and other Colleges.
- The Examiners of the London University.
- The English Jurors at the Paris Exhibition of 1867.
- The Society's Judges in Art-Workmanship.
- The Society's Examiners in Education.
- The Society's Visiting Officers.
- The writers of letters to the Schools' Inquiry Commission.

And many other gentlemen connected with education.

Members of the Society taking a special interest in this subject are invited to attend.

Examinations, 1868.

In addition to the prizes announced in the Programme of Examinations, the following are offered:—

The Worshipful Company of Coach and Coach Harness Makers offer as prizes—

1. A Silver Medal in Freehand Drawing; and
2. A Bronze Medal in Practical Mechanics;

To any candidate, being a workman or apprentice employed in the coach-making trade, who obtains the highest number of marks, with a certificate, in these subjects respectively.

The medals will be presented by the Master of the Company in open court.

Proceedings of the Society.

Food Committee.

The Committee met on Saturday, the 23rd of November. Present—Mr. Harry Chester (in the chair), Mr. J. T. Ware, Mr. M'Lagan, M.P., Mr. W. H. Michael, Mr. E. W. Hollond, Capt. Grant, and Rev. E. D. Tinling.

Mr. Merriam attended before the Committee to

give information respecting the manufacture and sale of preserved milk, as prepared by the Anglo-Swiss Condensed Milk Company.

Mr. Merriam, in reply to the interrogatories of the Committee, stated that he is a director of the above company, and agent in England for the sale of the article manufactured by them. Mr. Merriam explained that the article consisted of milk, from which a considerable portion of the water had been evaporated to the consistency of honey, with the addition of pure sugar; no other foreign substance whatever was introduced. Milk was so very cheap in Switzerland that there could be no advantage in adulterating it. The process was simply abstracting the watery particles from the milk, and the addition of the sugar. Upon the recommendation of Dr. Liebig beetroot sugar was used, on the ground that its preservative qualities were as good, and the price cheaper than cane sugar; in saccharine properties it was stated to be equal to the other sugar. It was also more bulky, though a pound of beet sugar contained as much saccharine matter as the same amount of cane sugar. The milk thus prepared he had seen after it had been open six months. It was in no way spoilt, though dried to a great extent. It was neither sour, rancid, nor mouldy. He had also seen a can opened about a year after it had been made, and it was in good condition and sound. It would bear the ordinary changes of temperature without injury. It was sold in canisters, which contained the equivalent of rather more than half-a-gallon of good milk, of about the quality of the best country milk. Dr. Liebig estimated that the addition of five parts of water would produce a quality equal to the original Swiss milk, and the richness was reduced according to the quantity of water added; whilst a smaller quantity of water made it of the consistency of cream, and, indeed, the cream would rise to the top. He had no concern with the retail price at which the article was sold; but the price of the canister on the table was 1s.3d., which was equal to half-a-gallon of a very rich quality of milk. The canister would probably cost a penny, and the duty was a penny per canister, which made the price of the milk, as diluted for use, sixpence per quart. For each canister the quantity of sugar was about one-third of a pound, so that less sugar was required when it was used for domestic purposes. The quantity of sugar used in the preparation might be considered by some people objectionable, but when given to young children was beneficial. No doubt a smaller quantity of sugar would be sufficient to preserve the milk for a moderate time in a climate like that of England, but up to this time no difference in that respect had been made in the preparation, and a large quantity of the article was sent to warm climates. He estimated that the sugar cost as much as the milk. The reduction of the quantity below what was now employed might endanger the preservation of the article. Milk was sold in Switzerland by the maas, and 2½ maas were equal to our gallon. It was claimed for this milk that it was more wholesome as food for very young children than ordinary milk, on account of its invariably uniform quality; and this was not the case with dairy milk in the country, because the milk of two cows was not of the same quality, and it varied at times in the same cow. One great recommendation of the article was the uniform quality of the milk, which, from the large bulk made at the same time, was secured in the highest possible degree. In the manufacture of this article the milk was brought on men's shoulders and emptied into a large reservoir, and within one hour after the whole quantity was put under the process of condensation. The preparation of the milk took place so quickly after its delivery at the works that no change could take place. He had not heard of any butter being made from this condensed milk, but the cream would rise on it when diluted for use. He considered this form of milk advantageous for family use in all cases where a supply of pure and good milk could not be guaranteed. The article was not protected by any patent. The manufactory was situated on the Lake of Zug, a very short distance from Zurich. The government authorities there were very rigid in their measures with regard to adulteration of food, especially of milk. There had been several instances in which the milk sent by the farmers had been rejected by the managers of the works. Each farmer's milk was tested. A sample was set aside to see if the cream rose, in order that they might know he was not cheating them. That was done every day, and then if there was anything unusual in the milk it was detected. If the milk was poor and thin it was rejected. That was all the company did; but the public authorities had in several instances taken up cases of adulteration of milk, and punished the offenders for selling bad milk; but in this country we were exposed to adulteration without any legal redress. Such was the system generally throughout Switzerland. The test of the milk was not so much by the lactometer as by the rising of the cream. There were shallow pans in which the milk was set. The specific gravity was not always a test to be relied on, inasmuch as other matters were put into milk to replace those which had been taken from it. Adulteration of that kind might be practised if they depended upon the test of the lactometer. Each dealer's milk was tested, and if the ordinary quantity of cream did not rise it was rejected. The sale of the condensed milk was increasing in England. Last month there were sold for home use and shipping as many as 1,250 doz. The Director-General of the Medical Department of the Navy had expressed his approval of it for use in the navy, but would not adopt it till it had been more tried in hot climates. At present desiccated milk was used in the ships, but the milk was not so good as this, because the desiccating process broke up the globules of the milk.

The Chairman suggested that experiments should be tried with regard to the smallest possible quantity of sugar which would be sufficient to preserve the milk in a climate like that of England for a short time, so as to make it available for family purposes. He considered the extreme sweetness of this preparation was the great objection to it.

Mr. Merriam thought it probable that half the present amount of sugar would suffice for the use of the milk in this country. That would have reference to the regular milk business. They could hardly expect the milk dealers to take it up; nor did he think it was desirable. If the company used the article in that way they would be placing themselves on a par with other dealers, and it was difficult to make people believe that they were honest with the milk they supplied in the ordinary form in which it was used for family purposes, and, the article once out of the hands of the company; they had no control over it. In its present form the milk would keep good for years; if it was not properly prepared it would not keep good. The Peninsular and Oriental Company, the Royal Mail, and the Pacific Mail Companies used this milk on board their vessels. With regard to the desiccated milk, the globules were broken up, and it was no longer milk. All that was done with this milk by the Swiss Company's process was to deprive it of the water. Microscopic observation showed that the substance of the milk, after condensation, was unchanged, and analysis of the water abstracted from the milk showed that the original properties of the milk were all retained. The process of manufacture was fairly given in the report of Dr. Liebig, a copy of which he furnished to the Committee. That report, however, did not go into the details of the extreme cleanliness which was obliged to be observed in the manipulation of the milk. On that account a spot was selected for the manufacture where there was an abundance of fresh water. The tanks and tins were cleaned with steam and hot and cold water, and steam was passed through them after the milk had been evaporated. The object of that was to render every

part of the apparatus perfectly sweet, and free from any taint from the milk previously operated upon; because, if anything was left behind which was liable to turn sour, not only would the company injure its reputation, but would suffer in pocket, inasmuch as the quantity of milk heated in one operation was generally as much as from 750 to 1,000 gallons. After the milk had been placed in the vessel it was heated by steam, and the milk was evaporated *in vacuo* at a low temperature. The whole process was completed in about two hours. As soon as the gauge indicated that the evaporation was completed, the steam was turned off, and the mass of milk so heated was put into tins, and closed up ready for use. He was not able to give all the details of the process, as the practical operator could do; but he would endeavour to lay some further particulars before the Committee on a future occasion.

The CHAIRMAN inquired with regard to the price of this article, comparing this with other forms of preserved milk, or butter, or cheese. Would it not be possible to sell this milk at a lower price than was now charged for it? It appeared to be about a penny per quart more than the price of the best London milk, which was liable to spoil soon.

Mr. MERRIAM remarked that as a set-off to that there was the sugar. It would amount to about sixpence per quart on the average. A canister of this milk, diluted to the consistency of ordinary London milk, would make about three quarts, and that would bring the price down to that of ordinary milk.

The Committee, having thanked Mr. Merriam for the valuable information he had given, then adjourned.

On Friday, the 13th December, the members of the Society and their friends attended at the Society's House to witness a practical demonstration of Captain Warren's apparatus for cooking for the army and other large bodies of people, and M. Sorensen's Norwegian cooking-boxes.* Messrs. Allen and Hanbury, Plough-court, Lombard-street, showed various soups made with the Liebig's *Extractum carnis*. Bread from the patent entire wheat-flour, from the St. James's-mills, Hatcham, was shown by Mr. Bonthron, of Regent-street, and the patent condensed milk by Mr. Merriam, of 95, Leadenhall-street. A description of Captain Warren's cooking apparatus appeared in last week's *Journal*. The apparatus shown was of a size suitable for cooking for 130 men, and the following is a statement of what took place:—

Weight of wood used	1 lb.
„ coals „	19 lbs.
Fire lighted	10.50 a.m.
Steam up	11.15 „

	Weight before cooking.		When put in.	When taken out.	Weight after cooking.†
	lb. oz.				lb. oz
Leg of mutton	8 14	"Warrenized"	11.15	1.45	7 12
Ditto	8 10½	Ditto and browned	11.15	12.45 [And put in oven and dished up 1·40.]	6 6
Ditto	8 4	Boiled	11.20	1.40	6 11
Chicken	2 10½	Roast	12.35	„	...
Ditto	2 6	"Warrenized"	12.35	„	...
Ditto	2 4½	"Warrenized" and browned	12.35	„	...
Ditto	2 7	Boiled	12.35	„	...
Potatoes	10 0	...	12.40	„	...

* Capt. Warren's apparatus is manufactured by Messrs. Adams and Co., 41, Marshall-street, Golden-square; and M. Sorensen's establishment is at 13, Duke-street, Grosvenor-square.

† There was a pint of the essence of meat in the cooker not accounted for in weighing when dished up.

Attention was particularly called to the meat, which is termed "Warrenised" in the foregoing statement. It is cooked, as described in last week's *Journal*, in a dry heat, no water or steam being allowed to come in contact with the meat, which is placed in a tin vessel with a double skin, by means of which the steam circulates round the interior, keeping it hot, whilst no steam can get at the provisions. The advantage of this mode of cooking appears to be that the meat is more juicy, and that there is less loss in cooking. It will be observed, that while the legs of mutton cooked in the ordinary way by boiling lost 1 lb. 9 ozs. in 8 lbs. 4 ozs., or about one-fifth, the "Warrenised" leg lost only 1 lb. 2 ozs. in 8 lbs. 14 ozs., or about one-eighth. The meat which was browned in the oven showed a still greater loss, but it must be remembered that this joint was kept in the oven a very much longer time than was necessary, being there 55 minutes, instead of 15, the usual time allowed. A joint roasted in the ordinary way loses about one-third in weight.

The principle on which the Norwegian cooking apparatus acts was fully described in the Society's *Journal*, vol. xv. p. 664. It simply consists of a wooden box, lined with thick felt, with a close-fitting lid, also thickly lined with felt, by means of which the heat of any article enclosed in it is retained for a long time. The joint to be cooked is placed in a tin vessel, with water, and brought to the boil, and after so boiling for five minutes the vessel is placed in the box and the lid closed down; the heat being thus retained the cooking continues, and at the end of a given period the meat is found thoroughly cooked. On this occasion the dishes cooked were a leg of mutton, potatoes, greens, pea soup, Irish stew, boiled fowl, roast fowl, and beef-steak, the two latter articles being cooked by means of a layer of butter at the bottom of the tin instead of water. The dishes were heated in the Society's house, and the boxes sealed down until they were opened in the presence of the members, when the various dishes were found completely cooked.

Messrs. Bonthron's bread from the entire wheat was tasted by the company. It is a brown bread, and the flour of which the bread is composed contains all the constituents of the grain. The bran, which in ordinary flour is entirely separated from it, is, in this instance, re-ground very fine and again mixed with the flour.

A full description of the condensed milk, shown by the Condensed Milk Company, will be found on the preceding page.

Allen and Hanbury, of Plough-court, Lombard-street, exhibited Liebig's extract of meat, manufactured in Australia by Mr. Robert Tooth. Excellent soups made with the extract were provided for the visitors. They consisted of mullagatawny, julienne, and pea and barley soup; the last-named was made after the recipe that has been in use during half a century at the Spitalfields Soup Kitchen, extract of meat taking the place of fresh meat. The receipts for the three soups exhibited at the Society's House are appended, extracted from a little pamphlet, issued by Messrs. Allen and Hanbury, entitled, "True Extract of Meat, What it is and How to Use it," which contains a history of the manufacture of the extract in Australia, together with a large number of receipts for the guidance of families using it. Extract of meat lozenges were also shown. Each lozenge is stated to contain half its weight of the extract, thus offering a peculiarly advantageous form for taking it.

The receipts for the soups shown are as follows:—

Mullagatawny. (For two quarts.)—Cut into dice 6 onions, 4 ounces of lean ham, and one carrot. Melt 4 ounces of butter in a stewpan holding about 2 quarts; fry the ham, carrot, and onions, stirring them till they become slightly brown; add four ounces of best flour, and continue to stir for 10 minutes; now add three tablespoonfuls of curry powder, 1 apple cut into thin slices, 2 quarts of Stock No. 1,* and five teaspoonfuls of the

extract of meat ($1\frac{2}{3}$ ounce); boil for one hour gently by the side of the fire; skim, and while boiling add a bunch of herbs, consisting of four sprigs of parsley, 1 of thyme, and 1 bay leaf; when done, rub through a tammy or hair sieve, heat till boiling, season according to taste, add the squeeze of a lemon, have ready some nicely boiled rice, and if convenient, serve with one piece of chicken to each person.

Potage Julienne. (For two quarts).—Cut into fine shreds 1 inch in length, 1 carrot, 2 turnips, 1 head of celery, 4 leaves of lettuce, and half an onion, and boil them in water for five minutes; strain and put them into a stewpan with a pinch of pounded sugar and a piece of butter the size of a walnut; cover them down closely till they begin to brown; add two quarts of Soup No. 8;† boil till the vegetables are done, and serve.

Pea and Barley Soup.—Extract of meat one ounce, pearl barley $\frac{1}{2}$ lb., split peas $\frac{1}{2}$ lb., onions 1 oz., salt (according to taste) say $1\frac{1}{4}$ oz., pepper (according to taste) say 30 grains, water sufficient to make up to 1 gallon; soak the pearl barley and peas in water for 24 hours; then boil for 4 hours with the onions (chopped fine), salt and pepper, and lastly dissolve the extract of meat in the boiling liquid.

This is adapted as a cheap soup for distribution to the poor, and is stated to be nutritious and agreeable; it may be made richer and better adapted for family use by increasing the quantity of the extract of meat.

The following table for making this soup in various quantities may prove useful:—

To make	1 Gallon.	4 Gallons.	12 Gallons.	20 Gallons.	40 Gallons.
Take of					
Extract of Meat	1 oz.	4 ozs.	12 ozs.	$1\frac{1}{4}$ lb.	$2\frac{1}{2}$ lbs.
Pearl Barley	$\frac{1}{2}$ lb.	2 lbs.	6 lbs.	10 lbs.	20 lbs.
Split Peas	$\frac{1}{2}$ lb.	2 lbs.	6 lbs.	10 lbs.	20 lbs.
Onions	1 oz.	4 ozs.	12 ozs.	$1\frac{1}{4}$ lbs.	$2\frac{1}{2}$ lbs.
Salt (according to taste) say	$1\frac{1}{4}$ oz.	5 ozs.	15 ozs.	$1\frac{1}{2}$ lbs.	3 lbs.
Pepper (according to taste) say	30 grs.	$\frac{1}{4}$ oz.	$\frac{3}{4}$ oz.	$1\frac{1}{4}$ oz.	$2\frac{1}{2}$ ozs.
Water, sufficient to make up to	1 gall.	4 galls.	12 galls.	20 galls.	40 galls.

Cantor Lectures.

"On Art; especially including the History and Theory of Sculpture." By Richard Westmacott, Esq., R.A., F.R.S.

Lecture 2.—Friday, December 13.

In urging upon those who really take an interest in art, the value and importance of education in its principles and position, the lecturer said he had, on the last occasion, referred to it as a means of increasing their enjoyment in looking at works of art, and of giving them self-reliance in forming a judgment on the merits of a picture or a piece of sculpture. He should, this evening, endeavour to place before them the various recommendations that a study of art possesses beyond its charm as an exponent of sentiment or of beauty, whether in form or colour. The public was not only generally uneducated in practical art, but it was equally uninformed in its history, and the important functions it fulfilled, as a contemporary record of the state of nations and of their civilisation, when the more ancient works were produced. As illustrations of the condition and habits of the people amongst whom it was, in its first ages, practised, the remains of old time had an interest far beyond what any modern art could offer. Monuments of sculpture, especially, were, at one time, the only records of memorable events. They pourtrayed the great acts of kings, heroes, and conquerors. They marked important historical incidents; and from them we had acquired an insight into the mythology and the poetry of the ancients. In these representations we had most curious and reliable authority for the costume and habits of remote nations of whom there was no written or other recorded account. Here, then, they stood out with an interest entirely their own, and independent of any recommendation, as regarded art excellence. There could be few present who had not seen the sculptures from Egypt, Spain, Hindustan, and from early Greece and Asia Minor, now collected in our British Museum. Some of these were of extraordinary antiquity, and we felt grateful for their preservation, while we stood, with a feeling akin to veneration, before works executed long prior to any written history. The monuments of Egypt probably mounted up to not less than 2,000 years before the Christian era. The sculptures brought from Nineveh and its neighbourhood, exhibited a comparative perfection of workmanship that showed long practice; yet we knew that the wonderful city from whose ruins they were exhumed, was utterly destroyed above 600 years before Christ. This comprehended a period of nearly 2,500 years, and many of the sculptures must have been executed long before this event. Incidentally the peculiar symbolic treatment of these monuments was explained, in the union of intelligence, force, and motion or activity, in the colossal and other figures where the human head appeared joined to the powerful muscular body and legs of the lion or bull, while enormous wings expressed the capability of rapid motion. The sculptures of the Parthenon from Athens, though not amongst the earliest works of Greece that might be referred to, had also that extra interest which was afforded by the certainty that from the age of Pericles all the greatest men of ancient classical times—generals, poets, historians, philosophers—had contemplated and doubtless admired those very productions. In the larger number of the older works of Assyria and Egypt, there were the most minute representations, both in painting and sculpture, of the everyday habits of the different nations; their wars and conquests, their amusements, their occupations in handicraft, their building, boating, in short, all the various business of life. Here, surely, was sufficient to give an absorbing interest to representative art, simply in its function of illustrating human life and progress.

The lecturer then proceeded to give a rapid review of the different schools of sculpture from the most ancient period. At about 450 years before Christ, sculpture, hitherto treated without reference to any art-excellence, began to be practised on a new basis. It was then not only used to illustrate the religious myths and heroic deeds of the Greeks, in the rude style of the earlier time, but the principle was introduced that these noble subjects should have their expression in the most perfect forms. Then began an entirely new phase of art, most important in its history, which made Beauty a condition of its practice. The school which ranked highest in this noble achievement was that under Phidias and his contemporaries, when the most sublime subjects were represented under the most majestic and dignified forms. To this succeeded the school of Praxiteles, who, departing from the more severe and pure treatment of the previous artists, made beauty itself the object and end of art. This, though the subjects were still religious, introduced a sensuous style, in works of exquisite and attractive execution. It was a downward step in art, because it made its appeal to the eye and sense alone, and not to the purer and more noble sentiments. After this came the school of Lysippus, which still further deteriorated from the high standard of the greatest masters. He was the favourite sculptor of Alexander the Great, and it was under that ambitious, self-glorifying monarch that portrait-sculpture was first introduced. Here individual character and details were studied, instead of the larger,

* Stock No. 1 is simply the liquor from boiled meat or bones, seasoned.

† This soup is "clear gravy soup."

general type of form seen in the most perfect works of nature; and, although productions of great merit were supplied by the sculptors of the period, and for some short time after the death of Alexander, the most perfect style of art ceased to be the object of study. The time during which sculpture, in its finest form, flourished, was comprehended in the comparatively short period of 200 or 250 years. The lecturer then traced what he called its downward course to later times—to its existence among the Romans, where, owing to the peculiar character of the nation, what was termed fine art, as it had been practised in Greece, excited little or no sympathy. The lecturer took occasion, after still further extending his survey, to return to the proposition with which he set out—namely, that there were many grounds of interest to recommend art to the attention of thoughtful and cultivated persons beyond its attractions as a means of mere representation or imitation, and as the outward expression of sentiment and beauty. He concluded by hoping he had succeeded in impressing this fact upon many present who, probably considering painting and sculpture only in an objective point of view, had not carried their interest in it beyond the pleasure it was capable of affording them as material art. This, of course, in these days was a great purpose of painting and sculpture; but the earlier function it fulfilled gave a dignity and character to its history which deserved the recognition of all persons of reflection and education. The higher the estimation in which any object was held the greater its interest and the reason of its attractiveness to all persons of sensibility and of cultivated minds. The lecturer said his purpose in dwelling on the uses and application of art in the earlier ages, its history and progress, independently of its material charm, was to incite this extra interest. He should be very glad if anything he had said or might say on this subject should be the cause of inducing those who attended his discourses to feel the importance of education in the history and principles of art; and to acquire themselves, and, if they had the opportunity, to extend to others, the knowledge which would so surely open to them a wide field of intellectual enjoyment and delight.

FIFTH ORDINARY MEETING.

Wednesday, December 18th, 1867; THOMAS WEBSTER, Esq., Q.C., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Caley, J. W., Norwich.
Duckett, Sir George F., Bart., Fangfoss-hall, Pocklington, Yorkshire.
Parker, John, 11, Goldsmith-street, E.C.
Ridgway, Matthew, Dewsbury, Yorkshire.
Smith, Griffiths, 2, The Grove, Highgate, N.
Webber, Thomas, 82, Lombard-street, E.C.
West, W. Cornwallis, Hedgebury-park, Cranbrook.

The following candidates were balloted for, and duly elected members of the Society:—

Atkins, Samuel Elliott (Deputy), Cowper's court, Cornhill, E.C.
Bath, Charles, Pfynone, Swansea.
Crowther, George Henry, Bond-terrace, Wakefield.
Davis, Lewis, 7, Bute-crescent, Cardiff.
De Jersey, Henry (Deputy), 13A, Gresham-st. west, E.C.
Dimsdale, Robert, M.P., 11, George-st., Hanover-sq. W.
Dodd, G. Ashley, 40, St. James's-street, S.W.
Fellows, Frank, Hampstead, N.W.
Haywood, W., Guildhall, E.C.
Jenkinson, William, 44, London-wall, E.C.
Legg, Cyrus, 192, Bermondsey-street, S.E.
Levick, John Musgrave, 27, Great Winchester-st., E.C.
Lindroth, Gustaf W., Drottinggatan, Stockholm, Sweden.
Miller, W. M., Tonic Sol-fa Choral Society, Glasgow.
Montgomery, Sir Robert, K.C.B., 7, Cornwall-gdns, W.
Page, Charles H., Dulwich-house, near Cardiff.
Phillips, J. S., 54, Euston-square, N.W.
Sims, Davis, 3, Bartholomew-lane, E.C.
Warne, Frederick, 15, Bedford-st., Covent-garden, W.C.
Woodley, Thomas, 74, Aldgate High-street, E.C.

The Paper read was—

ON THE PRINCIPLES THAT GOVERN THE FUTURE DEVELOPMENT OF THE MARINE BOILER, ENGINE, AND SCREW PROPELLER.

BY N. P. BURGH, ESQ., C.E.

I have separated the subjects I have this evening brought before your notice into three sections—Section A, the marine boiler; Section B, the engine; and Section C, the propeller.

SECTION A.

The principles on which the marine boiler is founded are the action of combustion, which produces heat; the conduction or passage of the heat through the plates and tubes; and the action of the heat and water combining, thus forming steam. There are obviously, therefore, three separate functions to be noticed, and if either is neglected, a proportionate amount of power is lost or is not developed; therefore, in dealing with this subject the properties of each portion must be duly considered. To begin, then, I must allude to the quantity of heat in the fuel and the correct mode of extracting it. The chemical properties of coal are, free carbon, hydrocarbons, water or oxygen, and hydrogen, and solid matter termed ash; the proportions of these vary considerably; in some instances, the solid matter is 25 per cent., while with superior coal only 6 or 10 per cent. The products of combustion, according to Professor Rankine, are carbonic acid gas, nitrogen, air, ashes, and steam in the following proportions:—

	Value.
Carbonic acid gas	·217
Nitrogen	·245
Air	·238
Ashes	·200
Steam	·475

The mean value of these products is ·275, but the Professor prefers the lower value, ·237, as the mean specific heat. The total amount of heat that is in one pound of ordinary coal is 14,500 units; but for marine purposes 14,000 will be a nearer equivalent. Then, as there can be no combustion without the admission of air into the fire-box, I must next notice the amount of air requisite per pound of fuel consumed, which is, on the average, about ten pounds of air per pound of coal. Some authorities estimate it as twelve pounds, but I think the former amount the more practically used. It must not be forgotten also that, exclusive of the oxygen requisite for combustion, air is required in the form of draught, so that totally twenty pounds of air per pound of coal consumed is admitted into the furnace.

If it is required to know the maximum amount of heat in a furnace, the following formula is used:—Divide the total heat in 1lb. of coal by the least amount of air in lbs., plus 1 lb. of fuel multiplied by the mean specific heat, and the quotient equals the number of degrees Fahr. Suppose, for example, the following figures:—

Total heat =	14,000..h
Amount of air requisite for combustion..	19 lbs...a
Coal in lbs.	1 lbs...c
Specific heat in the coal	·237..s
Temperature of furnace	x

Then $x = h \div [a + c \times s]$ or equal to 3,059 deg. Fahr. You have therefore the fact before you that there is a known amount of heat in a certain quantity of fuel, and the fault is ours, not that of the coals, if we do not extract that heat, and absorb it by the water surrounding the heating surfaces.

What indeed is most productive of economy in fuel is time for combustion; and with marine boilers, the time transforms itself into cubical space for the heat to be generated, and into heating-surface for the water to absorb it.

The diagram No. 1 is a section of a marine boiler of the latest arrangement, excepting the combustion-chamber, which in its usual form is shown by dotted lines, and the altered form in full lines. It will be seen that the action of the flame is attended to by curving the back and top of the combustion-chamber, for there is full evidence in most boilers that the flat or square top chamber does not receive the impact of the flame. Thus it is the contact of the flame with the surface that will produce evaporation, and if in any arrangement the action or traverse of the flame is not noticed, a waste of effect must result. It is evident that the flame inclines towards the tube-openings, and that the form of the flame's natural circuit is a curve from the fire-box into the combustion-chamber. It is obvious, therefore, that if the fire-box is prolonged, and the combustion-chamber enlarged, with its back-end curved, a better result will be obtained.

This management was advocated in a most extreme manner by Mr. C. Wye Williams, about ten years ago, in his prize essay on "Smoke Consumption," for which the Society of Arts awarded the Gold Medal.

In considering the action of the flame on the tube plate, we must remember, that surface is perforated, and thus a certain amount of free passage is permitted. Now, the crown of the furnace, also the back and sides of the combustion-chambers, are solid surfaces; but not so the tube-plate—it is an amalgamation of hollows and solids, and, although the flame may be driving directly against it, the hollows take off the effect from the solids, because the flame flows into the openings, and the intervening surfaces receive nearly a gliding action in effect. I may here add, I stated some years ago that the flame's action on the tube-plate must be thus—"The flame conforms to the required shape before it can enter the tubes, and therefore a total disturbance beyond or in front of the plate ensued; but that the greater the draught, the more would the tendency to an impact on the plate occur; and also that in some cases minute hollows were formed and destroyed in succession with such rapidity, to ensure nearly the actual contact of the flame and the surface between the tubes.

I must now allude to the flame's action within the tubes. In this instance we have a parallelogramic passage for the flame to traverse, and therefore the impact of the flame is sliding, not direct; a loss of effect therefore occurs; so that, if the flame were retarded in its progress, more time would be allowed for absorption. It is for this reason, I believe, taper tubes will be eventually used.

Now about the length of the tubes. Doubtless most here will agree with me that it is due to the want of space that they are as short as they are, and that the longer a tube is the more evaporation must ensue. In locomotive boilers the tubes are about 2in. in diameter, and 10ft. 6in. to 11ft. 6in. long, being an average of 66 diameters for the length; but with marine boilers 7ft. is the maximum length, and the diameter $2\frac{1}{2}$ to 3in., being a proportion of about 35·4 diameters, or, in round numbers, about half of the locomotive practice.

While noticing the conduction of heat, I may as well remark that it is generally acknowledged by various authorities on that subject that the value of the absorbing power of any body is in an inverse ratio to its reflective property, or, in plainer terms, a body that is a good absorbent is a bad reflector, and *vice versa;* but in the present case we do not desire to absorb the heat for a time, and give it out after by radiation, but rather to conduct the heat immediately into the water, amalgamate with it, and produce the vapour known as steam. Now, if we notice the conductive property of metals, we shall have no difficulty in coming at their relation for evaporative purposes, from the following table:—

	Conductive property for transmission of heat.
Copper	1,000
Brass	468
Wrought iron	336
Cast iron	311

Here it is evident that copper is the best agent for the conduction of heat; but we have not only "heat" to consider but also the strength of the material while it is performing the act of conduction, to which matter I will next allude by the following table:—

	Tenacity in lbs. per sq. inch.
Copper (cast)	19,000
Brass ,,	18,000
Gun-metal (cast)	36,000
Iron (wrought)	51,000
Iron cast	20,000

Now, as the tenacity of gun-metal exceeds that of copper, the former is mostly used for tubes, being next in strength to wrought iron. I may here allude to the fact that large wrought-iron tubes have been used with much success.

In my own practice, for general purposes, I consider the following proportions of the value of heating surfaces:—

Fire box—		
Crown, surface	1·000	value.
Sides above fire-grate	·500	,,
Combustion chamber—		
Crown and part curved back surface	1·000	,,
Tube-plate, effective surface	·875	,,
Back (curved)	·503	,,
Ends	·400	,,
Tubes—		
Total length (if copper)	2·976	,,
,, (if gun-metal)	2·5	,,

Now these values can be increased by allowing more time and draught for combustion, so as to burn the carbon which otherwise accumulates on the surfaces in question, and the carbon being a non-conductor, the value of these surfaces becomes gradually lessened, and the plate burnt.

The preceding calculations refer to coal or solid fuel. Lately, however, liquid fuel has been introduced, in the form of mineral oil, such as petroleum and parafine; these liquid hydro-carbons have given out fair results in some instances, more especially the former. A great deal of information in this matter can be gathered from a paper by Professor Rankine, "On the Economy of Fuel, comprising Mineral Oils," read at the Royal United Service Institution, a little time back. In the discussion it was elicited from Mr. Richardson, C.E., that "liquid hydro-carbon will evaporate 16lbs. to 18lbs. of water per lb. of fuel, and that 200lbs. of the liquid fuel would produce as much as 600lbs. of coal," being in fact a ratio of three to one against the latter fuel. Now the evaporative power of coal is generally about 8lbs. of water to 1lb. of coal in practice, but sometimes as low as 6lbs., so that if Mr. Richardson's figures are founded on practice the liquid fuel has a great advantage over the solid kind.

Having discussed the formation and conduction of heat in the marine boiler, I will next allude to the formation of the steam. To enable you to fully appreciate the value of a certain quantity of heat generated, I will quote from Professor Tyndall's work on "Heat as a Mode of Motion," wherein he states that Mr. Joule found that "the quantity of heat which would raise one pound of water one degree Fahrenheit in temperature is exactly equal to what would be generated if a pound weight, after having fallen through a height of 772 feet, had its moving force destroyed by collision with the earth. Conversely, the amount of heat necessary to raise a

pound of water one degree in temperature, would, if applied mechanically, be competent to raise a pound weight 772 feet high, or it would raise 772 pounds one foot high. The term 'foot-pound' has been introduced to express in a convenient way the lifting of one pound to the height of a foot. Thus, the quantity of heat necessary to raise the temperature of a pound of water one degree Fahrenheit being taken as a standard, 772 foot-pounds constitute what is called the mechanical equivalent of heat," which fact is worthy of more universal attention than at present.

The direct conversion of the water into steam, I believe, is spherodial, *i.e.*, the water is formed into minute oblate spheres filled with the heat, after which into globes, and thus is passed into what is termed saturated steam; but also bear in mind that the more heat put into the water, or the higher the pressure of the steam, the thinner and smaller will the spheres be, and therefore the lesser saturated the steam. This law is the cause for superheating the steam, and putting a safety-valve on the superheating chamber to prevent an explosion from the further generation of steam in the superheater.

Next as to the cause of incrustation and priming. In considering the former, I must first direct your attention to the analysis of the sea-water, consisting of as follows in relative quantities:—

Water	964·745
Chloride of Sodium	27·059
Chloride of potassium	0·766
Chloride of magnesium	3·666
Bromide of magnesium	0·029
Sulphate of magnesia	2·296
Sulphate of lime	1·406
Carbonate of lime	0·033

Generally there are only traces of iodine and ammoniacal salt, and the average specific gravity of the water is about 1·0274 at 60° Fahr. Now it is evident from the above figures that about $\frac{1}{28}$th of the total bulk is soluble matter.

The effect of incrustation on the heating surfaces is, that in proportion to the amount of solid matter accumulated, combined with its non-conductive property, so will the evaporation be retarded, and the relative plate exposed to the action of the flame be burnt, so that two evils are produced actually from one cause. Now there is no difficulty in the present day in preventing incrustation entirely, simply by using surface condensed steam as feed water; but when this is used alone, the boiler suffers from the galvanic action of the mineral property and grease in the water, which the latter has robbed from the surface condensers and cylinder. It will be remembered I have stated that the incrustation formed by the sea-water is almost a non-conductor of heat; it is also a non-conductor of galvanic action to some extent, therefore, by allowing a certain amount of sea-water to mingle with the surface condensed feed-water, the internal surface of the boiler below the water level is coated to a thickness of about one-sixteenth of an inch, and thus the pitting or wearing of the plate is prevented.

The origin of priming can be traced from various sources, such as imperfect distribution or circulation of the water in the boiler, proportionate to the value of the heating surfaces; insufficient steam space; shallowness of the steam space; sudden escape of the steam, or an extra rush of steam into the cylinders; change of feed water; and the opening of the throttle-valve too wide. I have often found the latter cause more certain than any other; and doubtless it is due to the exit of the steam exceeding the formation to some extent, and the water rises after the steam, or follows in its wake; it is for this reason, also, I have known high boilers to prime less than low ones. Another remedy is, to make a chamber inside, at the roof of the boiler, extending around the sides and ends; the steam enters this chamber through perforators or slots; and a plate at an angle beyond them prevents the water from entering also, unless in extreme cases. The advantage of this arrangement is obvious, when it is remembered that the steam is compelled to escape equally from the total area in plan; whereas, with an ordinary steam pipe opening, the rush is always at that locality. A third, and the latest, guard against the evil is a cylindrical vessel in the engine-room, which is close to the throttle-valves, and is so arranged, that, in the event of priming, the water so separated from the steam, and is received into the vessel, instead of going with the steam in the cylinders.

I have thus laid down the principles for further improvement, and my own conclusions are, that as heat is the prime mover, to it we must turn more of our attention, and in the place of 30 lbs. on the square inch, 60 to 80 lbs. for the steam pressure must be adopted for universal practice.

The following table of the proportions of marine boilers by the leading firms of England and Scotland terminates this section:—

Name of firm.	Name of ship.	No. of fire grates.	Length and breadth.	No. of tubes.	Length and external diameter.	Indicated horse power.	Consumption of fuel per hour per indicated horse-power.
Messrs. Penn	H.M.S. *Arethusa*	16	7 ft. by 2 ft. 10 in.	1,216	7 ft. by 3 in.	2,871	From 2½ to 5 lbs.
" Maudslay	*Roma & Venetia*	30	7 ft. 6 in. by 3 ft.	3,600	6 ft. 6 in. by 2½ in.	..	
" Rennie	*Charkieh* and *Dakahlieh*	12	6 ft. 6 in. by 3 ft. 6 in.	120	7 ft. by 3 ft 9 in. deep & 2½ in. wide	1,166	
" Watt	*Medusa & Triton*	10	6 ft. 6 in. by 2 ft. 11 in.	800	5 ft. 8 in. by 2¼ in.	1,040	
" Napier	H.M.S. *Hector*	24	7 ft. 5 in. by 3 ft. 2 in.	3,168	6 ft. 6 in. by 2½ in.	...	
" J. and W. Dudgeon	*Ruahine*	10	6 ft. 6 in. by 3 ft. 1¾ in.	608	560 = 3⅞ in. and 48 = 2¾ in.	1,540	
			Area of fire-grate surface.		Total heating surface.		
" Humphrys	H.M.S. *Pallas*		420 ft.		11,400 ft.	3,768	
" Ravenhill	H.M.S. *Lord Clyde*		700 ft.		Tubes, 19,000 ft.	6,065	

Section B.

I have shown you in the preceding section that steam is simply composed of heat and water, and you are also aware that the higher the pressure of steam, the more heat is put into it. Now, any heat wasted, bear in mind, is actually fuel consumed without effect, which is the reason for steam jacketing the cylinders. Were there time and space I would prove to you that the loss of heat by radiation, both with the boiler and engine, is considerable, and that tons of fuel consumed have never performed any duty. To mend this we must work the steam expansively, with high pressures, and simple gear for the cut-off—not to be used as a plaything, but as a requisition of practical value.

The theoretical law governing the rate of expansion is that, inversely as the cubical contents for expansion increases so will the pressure be reduced; which converts the following formula. To the cubical contents

for the supply add the cubical contents for expansion; divide this sum by the cubical contents for supply; the initial pressure of the steam divided by the quotient equals the pressure of steam when expansion terminates.

The valve I believe most practical for sea-going engines is the ordinary equilibrium, double-ported valve, of present universal use by the London engineers; and I think our attention, as engineers, knowing the value of a simple motion at sea, should be turned to perfecting this valve and the link motion, rather than running after foreign ideas composed of complicated arrangement and fancifully-formed valves.

The principles of the motion requisite for the slide-valve I have illustrated by the diagrams appended, which show the slide-valve of the latest proportions and the various lengths of eccentric rods, with the results of the proportions of those lengths, and positions. No. 1 depicts the position of the valve for lead; No. 3 for full steam; and No. 5 for cut-off, being the main positions during the entire motion of the piston. You will observe, I have shown the travel of the slide by the circle in dotted lines, also the length and angle of the eccentric rod in each case, while Nos. 2, 4 and 6, are the angles when the valve has a retrograde motion.

Than I ask your strict attention and remembrance of this fact, that as the position of the piston is affected by the connecting rod, so will the slide-valve be affected by the length of the eccentric rod; both travels are circles, and both rods are radii of larger circles; and put the matter in any form you prefer, these facts are the same. We know that the connecting rod is a radius, whose arc, intersecting with the centre line of motion, will denote a relative position for the piston, and therefore in no case can the angles of the crank be alike, when the positions of the piston are of equal distances from the ends of the stroke.

Now the eccentric's travel and rod are subject to the same cause, therefore the effect must be the same as I have already stated. Turning to the diagrams again for further explanation, No. 7 represents the circle of an eccentric travel, 11 inches in diameter, the lead for the valve being $\frac{1}{2}$ inch, outside lap 4 inches, width of steam supply opening, caused by the valve, $1\frac{1}{2}$ inch, and length of eccentric-rod only 36 inches. Now, notice that the length of the chord cutting the circle nearest the valve, is shorter than the one opposite; hence the versed sines, V V, are, in relation to that circumstance, also due to the radius of the circle being unalterable. The valve having an equal lead when the piston arrived at each end of its stroke, the points L L are due to the length of the eccentric rod, which determines an unequal position for the angle of the eccentric alone, and below the centre line. Here I may mention that the eccentric in practice moves with the crank, and no change of angle can ensue; but it is essential in the present instance to assume the angles changed due to the length of the eccentric-rod, if an even lead is required. The points, C C, are the angles of the eccentrics when the valve is cutting off the steam, and as the arc, L V, above the centre line is unequal to L V below opposite, so will V C above and V C below be unequal.

Compare next the diagram No. 8 with the one I have just explained. Here the eccentric's travel is only $3\frac{1}{8}$ inch—being for the valve shown by Figs. 1, 3, and 5, the lap being 1 inch, lead $\frac{1}{4}$ inch, width of opening 9-16 inch—but the eccentric-rod is in this case $46\frac{1}{2}$ inches long, so that L V and V L are nearly equal, and C V and V C bear a similar comparison with each other, and make no different relation in the versed sines. In No. 7 the lead is $\frac{1}{8}$th of the outside lap, but in No. 8 the lead is half of the lap, while the versed sines, V V, in the latter example, are nearly equal to each other.

No. 9 is another proportion; the outside lap is 2 inches, lead $\frac{1}{8}$th or 1-16th of the lap, width of opening caused by the valve, $\frac{3}{4}$ inch, diameter of eccentric circle, 6 inches, and the length of the eccentric-rod $41\frac{1}{2}$ inches. Here C V and V C are nearly equal; also L V and V L bear the same relation; also the versed sines V V.

I have further demonstrated by the diagram No. 10, that the versed sines of the crank and eccentric are alike in proportion. It is seen the crank has passed through equal arcs, also the eccentric, hence the cords and versed sines are relatively equal, but the grades of expansion, P P, are, of course, unequal. We shall understand this better from the diagrams Nos. 11 and 12. The cranks, C C, are shown in opposite directions, and the angles of the eccentrics, E E, due to the lead required; when the crank in No. 11 is rising, the eccentric is descending, as shown by the arrows, and reverse in No. 12. Another fact is, that this unequal expansion is also due to the connecting and eccentric rods being on the same side of the crank-shaft, so that the arcs of position, for both piston and valve, are in the same direction. This is the fault with all direct-acting engines, and although the fault may be remedied by unequal laps and leads, the principle of the action remains the same, hence this axiom, "that either lead or expansion must be unequal with direct-acting engines."

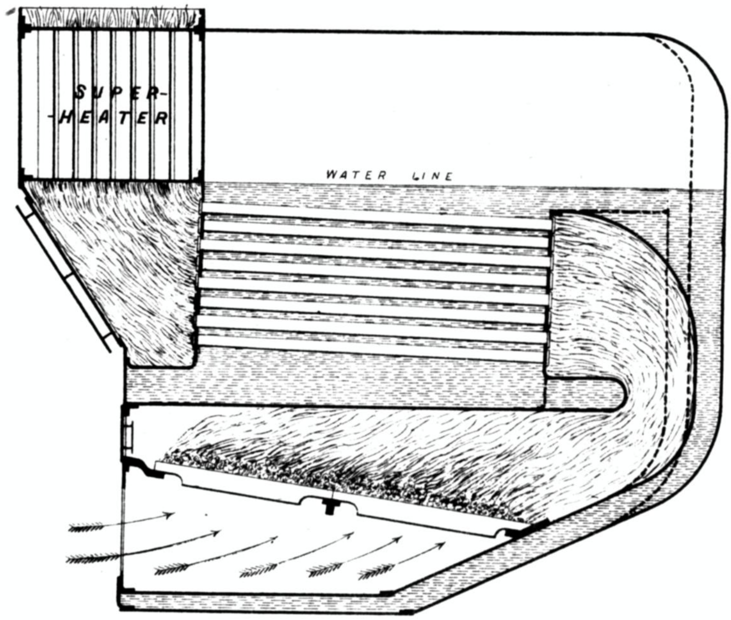
Now, having shown the bane, I will produce the antidote given by the diagrams Nos. 13 and 14. This is the return-acting type of engine as far as the position of the connecting-rod and slide-valve are affected. The arcs of positions for the piston are equidistant from the limit of the circle, C C; the arcs passed through by the cranks, C C, are, of course, unequal, and those described by the eccentric are the same. When the crank is on the horizontal line, the angle of the eccentric is shown by the dotted line above the horizontal line, and as the crank on rising passes through a certain length of the eccentric circle, the eccentric descends through a similar distance. Now the length of the connecting rod, C R, is five cranks or radii of the crank circle, and due to that length are the arcs of position. I must solicit your earnest attention to the fact that those arcs incline in a certain direction, to which I shall again refer.

The slide-valve is located opposite the connecting-rod, C R, and the length of the eccentric-rod E is five radii of the eccentric circle. The arcs of the valve's positions are thus relative, in a contrary direction to those for the piston. These arcs, therefore, being proportionate, but in opposite directions, a relative action must be certain.

Referring again to the unequal grades of expansion liable with direct-acting engines when the valve and connecting-rod are on the same side of the crank-shaft, I direct your attention to the enlarged diagrams, Nos. 15 and 16. Each were originally taken from opposite ends of the cylinder, and the difference in the positions of the piston at the points of cut-off termination of expansion and exhaustion, also the variation in the commencement of compression are faithfully depicted. You will notice that the length of supply steam is more in No. 15 than in No. 16, so that the points for cut-off must be unequal; also, that although the lengths for expansion are nearly equal, the termination of these points is nearer the end of the stroke in No. 15 than in No. 16. But there is a reverse action with exhaustion, being longer in No. 16 than in No. 15. With compression, No. 16 has also the advantage, being shorter than No. 15.

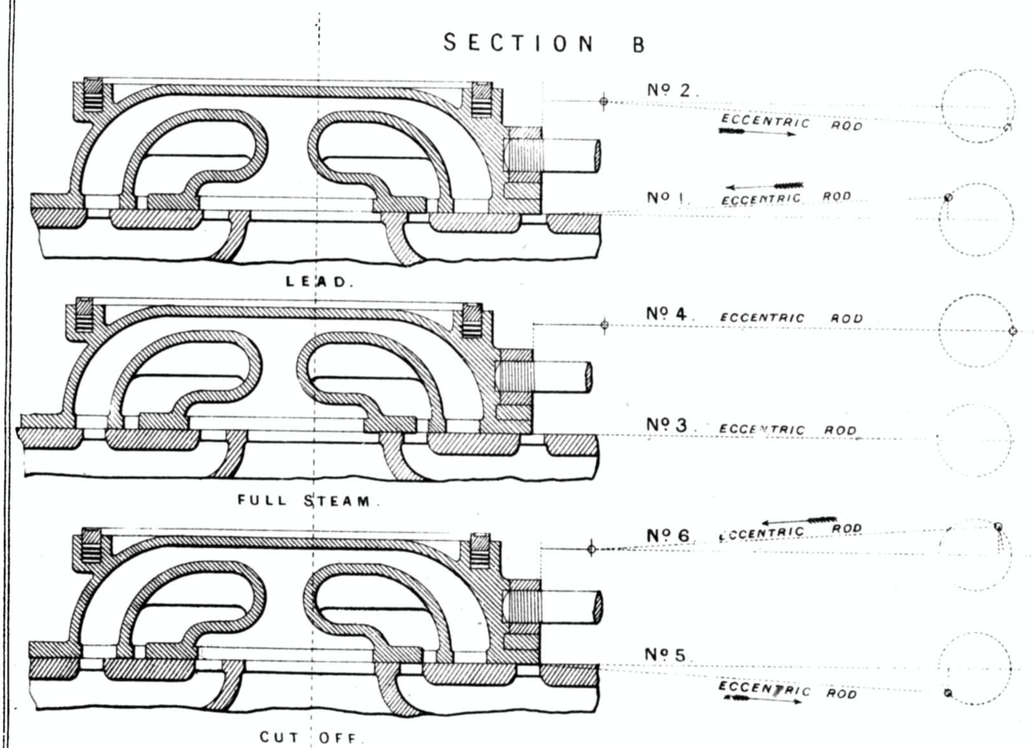
Having proved that the length of the connecting and eccentric rods, lead, and width of opening caused by the valve, determines the outside lap of the valve for a given grade of expansion or cut-off, I have condensed this matter into the simplest formula possible, in connection with my former statements and diagrams. To find the outside lap of the valve for any grade of expansion—divide the radius of the crank by the versed sine of the crank, multiply the quotient by the versed sine of the eccentric; the product, minus the width of the supply opening caused by the valve, equals the outside lap. The versed sine of the eccentric is the width of steam supply opening caused by the valve, minus the lead as a rule, but in exceptional cases, as shown, half the lead only.

SECTION A. No. 1.



Scale 5/16 in. = one Foot.

SECTION B

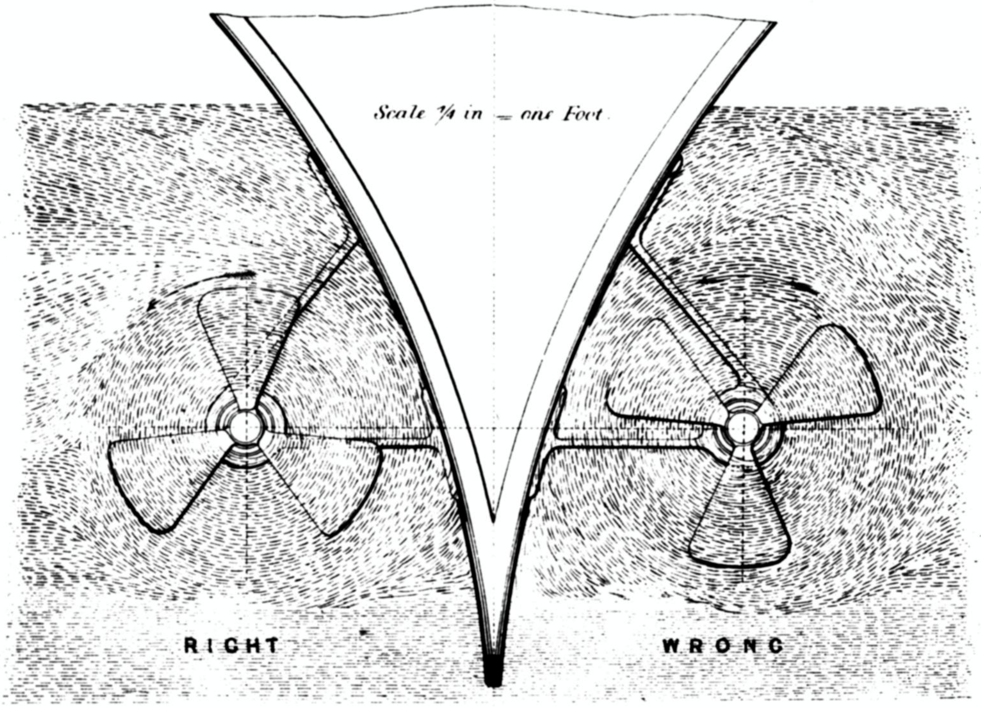


Scale 1¼ in. = one Foot.

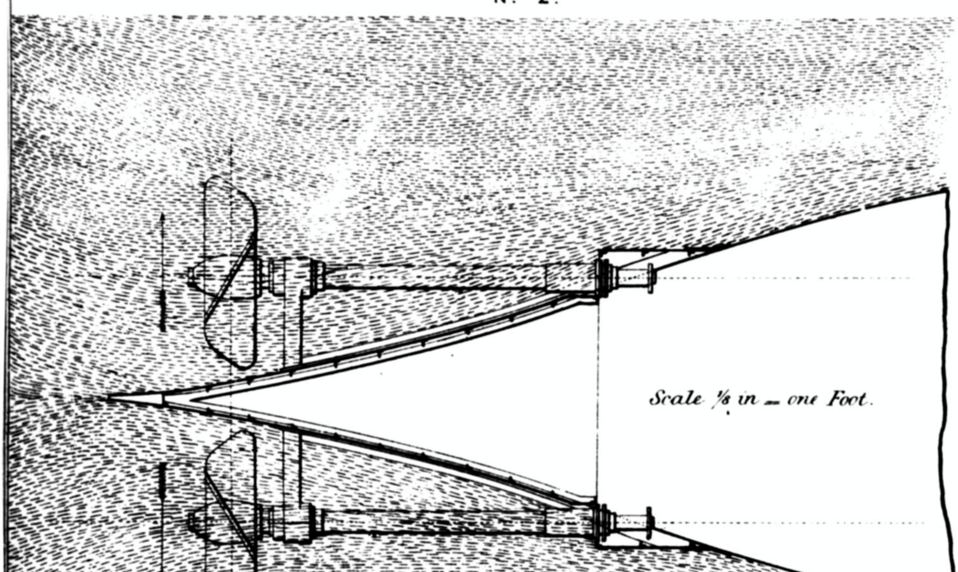
Newton & Alexander lith. 42 Castle St. Holborn.

SECTION C.

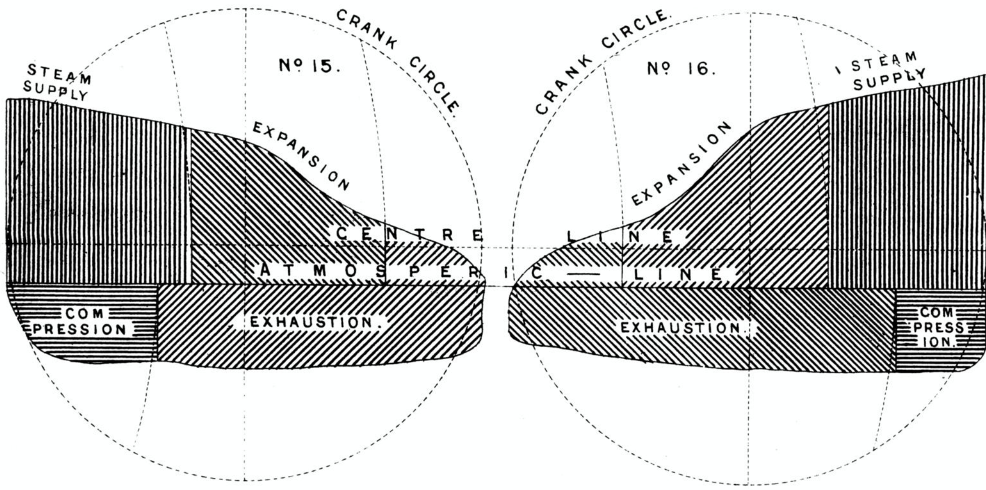
No. 1.



No. 2.

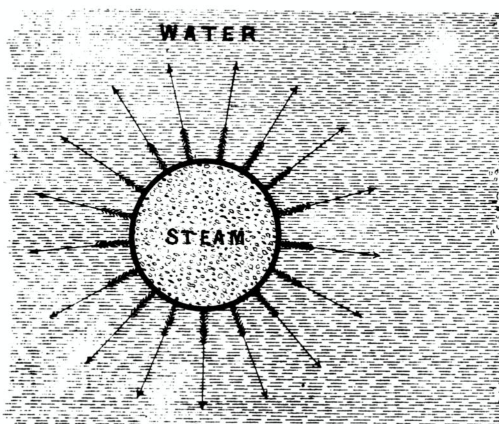


SECTION B.



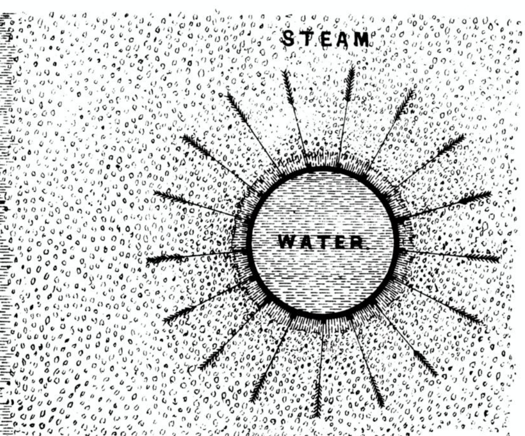
INSIDE CONDENSATION.

No 17.

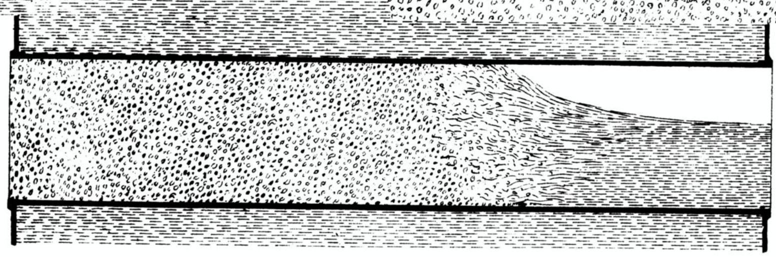


OUTSIDE CONDENSATION.

No 18.



No 19.

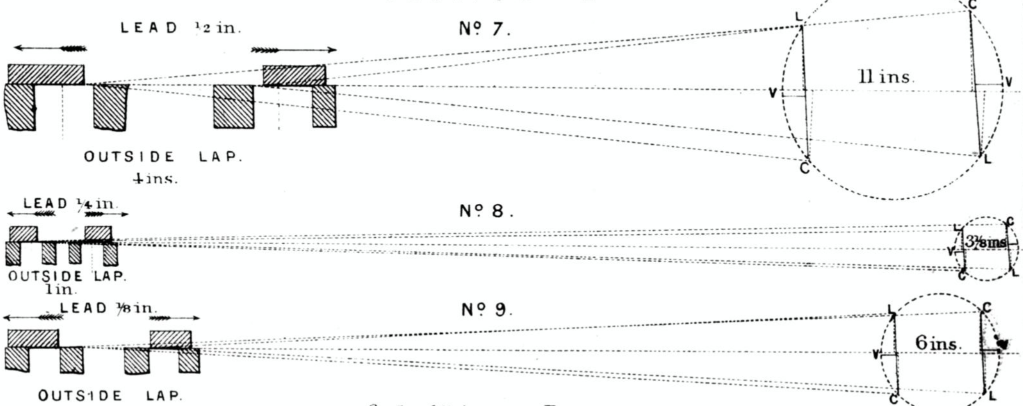


Full size diam^{r}

HORIZONTAL ACTION OF CONDENSATION.

Newbery & Alexander, lith. 43, Castle St. Holborn

SECTION B



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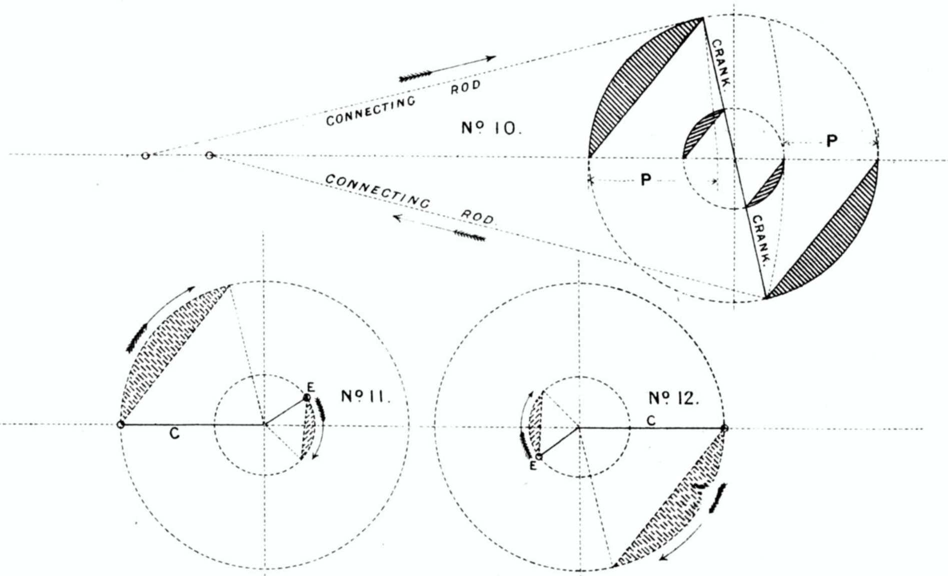

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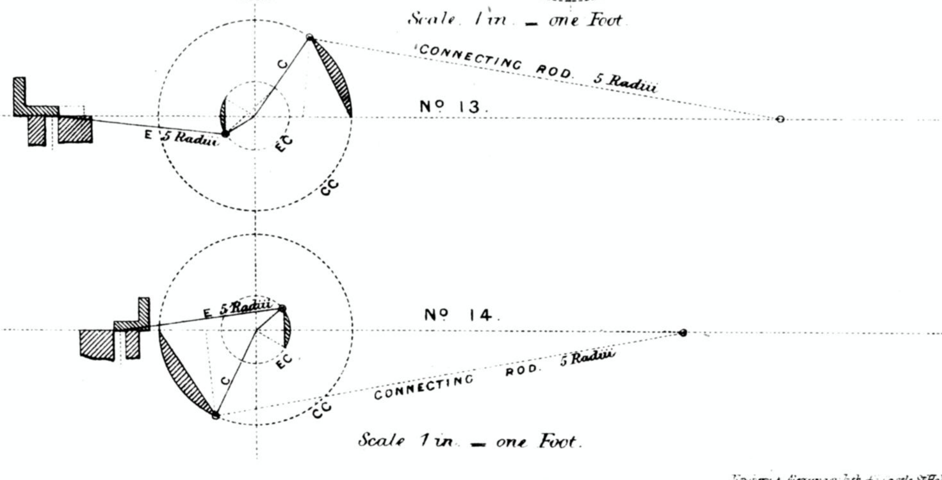

Scale 1 in. = one Foot.

Newbury & Neumann lith. 4, Castle St. Holborn

With reference to the link motion, I have not time to enter into that subject, but you will be satisfied, I trust, when I state that it can be arranged and proportioned to suit any requirement, which, in a future paper, I will explain.

I have now finished with the use of the steam as a power, and will presume exhaustion is taking place from the cylinder. This steam, bear in mind, is but heat and water; and if I extract the former, I have only the latter remaining. Now there are, as well known, two processes of doing this: either by water in contact with the steam, or a portion of metal intervening to prevent that contact, which, in technical language, are injection and surface condensation. The principle, then, is alike in each case; heat is extracted, or absorbed, by a cold power of continuous action; but mark the practical difference in arrangement. With the injection system, the cold water is converted into a spray of minute streams, or sheets, against which the steam rushes, and instantaneous amalgamation is the result, the water falling between the points of contact containing not only the heat, but the water also which formed the steam. An ordinary hollow vessel, of proportionate dimensions, with the injection-pipe, air-pump, and valves are all that is requisite. But with the surface condenser, tubes, circulating and air-pump valves, and casing are requisite. It becomes, indeed, a matter of surface for the cold water to act on, and the steam to be in contact with. You will remember I have told you that "time" for the absorption of heat is a great essentiality with marine boilers; and you will clearly understand me now, when I repeat that "time" bears the same relation for surface condensers, for the heat is extracted in either case, therefore the principles must be the same.

There are at present two kinds of surface condensation, internal and external; of course each has faults and advantages, to which I will briefly allude. To assist me in my endeavour to make myself understood, kindly direct your attention to the diagrams Nos. 17 and 18. You will perceive that with the steam inside (No. 17) the heat is absorbed by the water outside, in the direction of the arrows, which depict an expansion from the centre. Notice next No. 18, which shows the steam outside and the water in; here the heat is contracted to the centre, being a direct contradiction of the action in the former example. You will thus understand that with inside condensation a gain of area is effected, simply due to the direction of the rays of heat; they expand with the water outside the tube, but contract with the reverse locality. In the diagram No. 19 I have shown the horizontal action of condensation, proving clearly that taper tubes are as essential in surface condensers as in marine boilers.

I must now direct your attention to the great question of friction, and in so doing I will be as brief as possible. I will set aside, too, the cause for friction, for that I think you all know, and will therefore confine myself to the main effect, viz., the heat generated and the power absorbed. I think the generation of heat from friction is due to electric action, and the mechanical effect is that the atoms of the surfaces of the material in contact are disturbed, and are actually in motion so much as to grate against each other, and thus absorb the power which is required to keep up the speed of motion. I have had full evidence of this with heated bearings, for by strengthening the bolts, and a plentiful supply of spring-water, the two faces were reduced to their normal condition. I therefore permitted the metal to expand, or the atoms to be released from each other, and the cold water absorbed the heat caused by electric action.

The friction of the working surfaces in contact with marine engines is considerable; and I am afraid it is too often set aside, as unworthy of notice, that the lighter the running load of an engine is, the less the friction incurred, and the inertia to be overcome. Now there is no mystery in this, for it is indeed a matter of so many pounds weight to be overcome, or pushed forward and backward. And you will, I know, agree with me that the least weight of material having a retrograde motion, the lighter can the piston-rod, connecting-rod, and cross-head be formed. Remember that every pound of material shifted by the steam, requires an equivalent amount of fuel, and if you reduce the former, simultaneously the expenditure of the latter is reduced also. I could extend my views on this subject, but I have others of equal importance to lay before you, and I have given a table of the frictional surfaces of marine engines by three of the principal firms in London, which will give you more *bona-fide* information than any description:—

TABLE OF FRICTIONAL SURFACES.

Name of Detail.	Messrs. Penn's Trunk Engines, 500 h. p. nominal.	Messrs. Maudslay's Return-acting Engine, 900 h. p. nominal.	Messrs. Humphreys' Direct-acting Engine, 400 h. p. nominal.	Nature of Friction.
	Area in square inches.	Area in square inches.	Area in square inches.	
Steam Pistons	4884·6	6559·2	3984·3	Sliding.
Air-pump Pistons	753·6	832	1104	Sliding.
Steam Piston Rods, Stuffing Boxes	5390·84	1529·6	700	Sliding.
Air-pump Rods, Stuffing Boxes	354	600	309·6	Sliding.
Slide Valves, Rings and Rods	3546	4244	3622·52	Sliding.
Guides for Slide Rods	144	201·6	400	Sliding.
Connecting Rod Pins	396	681·5	175	Revolving.
Guide Blocks	none	899	742·5	Sliding.
Crank Pins	728	962·5	466·4	Revolving.
Crank Shaft Bearings	4550	5785	349·8	Revolving.
Eccentrics	716	1036	693	Revolving.
Eccentric Pins	57	110	40	Vibrating.
Link Block	48	50	72	Vibrating.
Feed and Bilge Pumps	753·6	796	637	Sliding.

Next you will find a table of the weights of the permanent load of marine engines; also of the several details, boilers, &c., kindly given by several notable London firms:—

WEIGHTS SUPPLIED BY MESSRS. WATTS.—DIRECT ACTING ENGINES, 976 H. P. ACTUAL.

	cwts.	qrs.	lbs.
Piston	19	2	26
One piston-rod	4	2	16
Cross-head and guide-block	4	3	6
Connecting-rod	10	0	2½
One main shaft with balance weights	60	2	0
One slide valve	9	0	0
One slide valve-rod	0	1	0
One guide or cross-bar	0	2	16
One link	1	3	24
Two eccentrics (2 0 18) and two rods (5 2 15)	7	3	5
Two plungers for air and circulating pumps	3	3	4

	cwts.	qrs.	lbs,
Six pieces of rods	1	3	16
Water in condenser	0	0	0
Two plungers for feed and bilge pumps	1	1	18
One turning gear wheel, with friction clutch and cone	45	0	0
Screw shafting	118	1	0
Screw propeller	43	2	0
Two engines 100 h.p. (nominal)	767	2	15¼
Condenser	245	2	0
Propeller and apparatus	159	3	6
Boiler	932	3	17
Fittings	117	3	26½
Water	0	0	0
Coal boxes	168	2	17
Donkey engine 9in.	32	3	2

Weight of Machinery and Boilers, 1,380 h. p. actual, fitted in the "Mary" and "Bolivar," Twin Screws, by Messrs. Dudgeon.

	Tons.	cwts.	qrs.	lbs.
Two pistons	0	19	2	0
Two piston-rods and guide-blocks	0	9	1	20
Two connecting-rods	0	11	3	0
One main shaft and crank	1	4	3	0
Two slide valves	0	5	1	0
Two ,, rods with pins, &c.	0	0	3	16
Two links	0	0	3	16
Four eccentrics and rods	0	8	1	0
Two pump-rods and pistons	0	1	1	0
Water in condenser	1	5	0	0
Feed and bilge plungers with levers	0	2	1	0
Turning wheel	0	10	2	0
Screw shafting	5	4	0	0
Screw propeller	1	8	2	0

Total weight of engines, condensers, and propeller, 63 tons; 1,380 h. p. actual; total weight of boiler, fittings, and water, 134 tons.

Weights Supplied by Messrs. Maudslay.—Return Action Engines, 1,350 h. p. actual.

	tons.	cwts.	qrs.	lbs.
One piston	3	10	0	3
Two piston-rods	2	4	13	3
One connecting-rod	4	16	0	0
One main shaft and crank	17	11	0	0
Two slide valves	2	14	2	0
One turning wheel	5	0	0	0
Screw propeller	23	0	0	0
Total weight of engines	283	0	0	0
,, ,, boilers	373	0	0	0
,, ,, mountings	253	0	0	0
,, ,, propeller and shafting	114	0	0	0
,, ,, water in boiler	190	0	0	0
,, ,, shafting (screw)	62	0	0	0

Weights Supplied by Messrs. Rennie.—Direct Acting Engine, 1,900 h. p. actual.

	tons.	cwts.	qrs.	lbs.
One piston	1	18	0	0
Two piston-rods, cross-head, and guide-blocks	4	6	0	12
Two connecting-rods	2	19	0	4
Two slide valve rods	1	16	2	14
One main shaft and cranks, and four eccentrics	6	2	2	0
Four counter-balances and straps	3	2	0	9
Two air-pump rods	0	3	3	26
One propeller	5	8	0	14
One shaft in ditto	4	13	0	10
Four shafts	9	8	1	14
One feed and bilge pumps	0	1	0	0
One turning gear	0	4	3	26
One governor, complete	0	8	3	16
Total weight of engines and boilers	275	0	0	0

Before I dismiss this section I must notice the common error of the day. I allude to the term and its meaning —nominal horse-power. Now let us see what are the principles on which it is founded. First, a fictitious pressure of steam, or much below what will be actually used; second, a fictitious speed of piston, estimated from a less number of revolutions of the crank-pin than is intended in practice; third, a wide margin in relation to the heating-surface of the boiler, being a demonstration indeed of the proverb, that "charity covers a multitude of sins," so that by a plentiful supply of heating-surface, the nominal horse-power can be made to look small by the side of the actual. I think, therefore, we should deal with the facts, and not with nominal conclusions, for, after all, the truth must decide the actual result, and therefore why go outside, when, by keeping within the limit, a shorter route is certain? It is, indeed, a matter of grate and heating-surface with pressure of steam; and, deal with it how you may, it comes back to that, so that when we are designing our boilers and engines, the actual result is before us, and we treat the nominal as a toy of convenience. That the word nominal is conventional, commercially, I will admit, but when the actual horse-power is guaranteed also, I cannot see the use of the former, unless it be, as I said before, to make the actual result look larger by the side of the nominal assumption.

Section C.

The screw propellers of the present day may be considered as the common Griffiths, and the French, or *Mangin*. The first, as the late Mr. Roberts, C.E., used to say, "is the screw in its natural state; and if you alter it, it isn't a screw;" that gentleman undoubtedly was correct in the main, for neither the Griffiths nor the Mangin types are real screws in the strict meaning of the term; they are the result of stepping outside the truth of the helical line to indicate the faults in other quarters if possible. The Griffiths screw has the extremity carried forward to grasp the water; the shape of the blade is irregular, not unlike the section of a pear. The "Mangin" production has two pitches connected at the centre of the blade, the leading pitch being less than the trailing or following.

The principles of screw propulsion embrace those relating to hydraulics also, so that in proportioning the screw the lines of the hull should be considered. We must remember that the fore-body of the hull drags the after-body in principle, the former pushes the water aside, and the latter allows it to return to its usual condition, which is termed the after-current. Now it is this disturbed water the screw revolves in, hence I think we want a little better acquaintance than at present with the subject, for you all know that, although two ships' propellers and engines are duplicates, and tried side-by-side, the results of speed are unequal, although the number of revolutions are identical; for example, take our two armour-plated ships, the *Warrior* and *Black Prince;* both are similar in design, dimensions, and power, but the *Warrior* steamed at the rate of 14·356 knots per hour, while her sister only attained a speed of 13·604 knots. Next the *Archilles;* her tonnage has an excess of 82 tons over the *Warrior*, but a four-bladed Mangin screw. She attained 14·322 knots, or nearly as many as the *Warrior* with her two-bladed Griffith's screw. Turning from the single-screw propulsion to the twin type, I will allude to the *Viper* and *Vixen*, also in our navy; both are the same power, within seven horses indicated, but the speeds are nearly half a knot difference, the *Viper* running 9·06 knots and the *Vixen* 9·475 knots per hour. The hulls are nearly duplicates, the difference in the tonnage being only three tons. I may mention that there was no difference in the draughts, taken as a mean—the *Vixen* drew one inch more aft than the *Viper*, and the reverse forward.

My convictions on the subject are that it is the skin friction we overlook, and my opinion on this is confirmed by the very slight difference comparatively in the speeds

with full and half-boiler power. I will take the *Bellerophon* as an example. With full-boiler power she attained a speed of 14·201 knots, and with half-boiler power 12·164, the revolutions being 72 and 64 respectively. So that it is obvious that the friction on the fore-body skin must be increased immensely as the speed is increased, but not in any direct proportion to the power required. I will notice next the *Viper*. At full-boiler power the indicated horse-power of the port engine was 325·05, making 9·06 knots; with half-boiler power the same engine indicated 157·33, with a speed of hull of 7·347, the revolutions being 104·5 and 85·72 respectively. I might enumerate dozens of such examples to prove the requisition of noticing the skin friction in the calculation for the requisite size of the screw and proportionate power of the engine. Professor Rankine, in his excellent work, "Rules and Tables," states first, "Given the intended greatest speed of a ship in knots, to find the least length of the after-body necessary in order that the resistance may not increase faster than the square of the speed—take three-eighths of the square of the speed in knots for the length in feet" (Scott Russell's rule). Secondly. To find the greatest speed in knots suited to a given length of after-body in feet, take the square root of 2⅔ times the length. Thirdly. For an approximate value of the resistance in well-designed steamers with clean painted bottoms, multiply the square of the speed in knots by the square of the cube root of the displacement in tons, but this resistance may vary from ·8 to 1·5 of that given by the preceding calculation.

In relation to the effective horse-power expended in propelling the vessel at a given speed, multiply the resistance of the hull by the speed in knots, and divide the product by 326; but more often, the Professor states, 200 is used as the divisor.

I know of no formula at present that gives us a lucid idea of the correct area for the blades of the screw proportionate to the forward form of the hull and the friction incurred. But I blame no one, for I have often tried the experiment, and failed. I believe the general practice is, as my own, to improve from the failure of previous productions; we cut off a corner of the blade or alter its pitch, or reduce the radius, as much to suit our tastes or experience as the knowledge we have of the future result. Of course the radius of the blade's edge, its width, its angle or pitch, and length on the line of keel, settles the area of the surface; but we require rather what that area should be beforehand for the purpose required.

Next, with reference to the diameter of the screw, some authorities state, "make it as large as you can," inferring that the lower half of the circle described by the screw is more effectual than the upper, which undoubtedly it is, due to the density of the water. If we want a proof of this we have only to consider that the currents caused by the hull are more disturbed at the surface or line of flotation than below it, therefore the deeper the screw is immersed, the more powerful agent it becomes. It is for this reason I have always advocated twin-screws; but before I enter on the subject, permit me to pay a tribute of respect to the originators of the system. I allude to the late Mr. G. Rennie and Mr. Roberts. Both have passed from us, but are not forgotten; and I am sure you will agree with me that it is to them we owe the root of twin-screw propulsion, which has been since so ably matured by Capt. T. E. Symonds, R.N., and the Messrs. Dudgeon. The former gentleman has been the principal exponent of the system for ships of war, and merchant vessels also, since the year 1862. He has also lately invented a novel mode of lifting twin-screws. Messrs. Dudgeon have brought the matter at issue to its present state by their bold but practical manner of treating the subject, their ships and engines taking the position of successful productions.

Now, with two screws in the place of one, we have a sub-division of the force applied. Taking the midship section of the hull as the transverse area of the resistance, what is the most correct position for the two screws? The answer, in accordance with natural laws, seem to me to be, the centre of the areas divided by the centre line of the hull. For this reason, I think the type of the engine should not settle the distance between the centres of the screw shafts, but rather that the latter distance is due to the the form of the hull, so that each screw shall be located centrally of the area it is propelling. Those who are strong advocates of the advantages of twin-screws for steering purposes, will naturally ignore my opinion, but in so doing will they not sacrifice the correct position for the centres of propulsion. I am confident, however, that the hull will be propelled at a higher speed when the screws are in the position I have advocated than otherwise, and the manœuvring powers will be but little if at all impaired to that if the screws were wider apart.

To enable you to appreciate the intrinsic value of twin-screw propulsion, I direct your attention to the diagram No. 1, where I have endeavoured to illustrate the probable action of the screw when turning from the hull or towards it. The principles I believe to be thus:—The screw is working in disturbed water, caused by the progress of the hull, and the least amount of disturbance added by the motion of the screw the greater propelling effect is certain. When the screw is turning towards the hull the water is dashed against it, and thus additional disturbance and skin friction are ensured.

When I state this, I do not overlook the fact that the screw is advancing; but, is not the hull also?—so that the disturbance is a continuation with the passage of the hull. The water agitated by the inward revolution of the screw, is not only dashed against the hull, but is forced between the centre line of motion before the screw has left it.

But in the case of the screw turning from the hull, the difference in the effect is evident; the fluid above the centre line of motion is forced from the hull, and, being lighter in density than the volume below, ascends, at an incline to the surface or line of flotation; it has performed its duty and departs from it, to make room for the new current, without adding any skin friction to the hull. It occurs to me that it is simply a matter of gravity or density of the various currents the screw revolves in, and the quicker and easier the screw revolves, the more power it developes. I believe it to be a question of speed, also proportionate to the pitch and depth of immersion, so that, in deducing the proportions of the screw, all these natural facts should not be overlooked. The action of the currents, at right angles with those I have just adverted to, is shown by the diagram No. 2. The surface current nearest the hull must be in contact with it; but those beyond gradually diverge outwards, which is my concluding proof that the propeller should turn outwards also.

I might have entered more into the details of all the matters I have this evening brought to your notice, but as I value your opinions, so do I now think the time has arrived for me to relinquish my claim on your patience, and solicit you to discuss my paper as you may think appropriate.

DISCUSSION.

Mr. John C. Wilson said that, in his opinion, the paper had not touched upon the principles which ought to govern the construction of marine boilers. All the questions about combustion of the fuel, the size of the furnace, shape of the flue, size, proportion, and length of the pipes, were the mere a b c of the matter. The vital principle was, if possible, to obtain a thorough circulation of the water over the heated surface of the boiler, and there was more effect to be gained by that than by any other detail or mode of construction. When the heat was applied to an iron plate it was at once conveyed to the water in connection with it, and if there were no circulation the steam was generated, and re-

mained a certain time in that position, which it ought not to do. What was wanted was, that as soon as the heat was conveyed to the water, converting it into steam, that steam should at once be conveyed into the steam chamber, and that a fresh portion of water should immediately come in contact with the heated plate. When the steam was formed on the surface of the plate, it had to pass through a large body of water before it emerged into the steam space, and the result was what was called boiling, a process which was not at all wanted in a boiler for a steam engine. Mr. Burgh showed a certain plan of passing the steam through perforated plates, by which priming would be prevented, but did not state the reasons why it was so. When any valve was opened, so as to relieve the pressure, the steam rushed out, carrying the water with it, but by causing the steam to pass through narrow apertures, the steam escaped more slowly. He, therefore, considered that their attention ought to be principally directed, in all boilers, to get a rapid circulation of the water over the heated surfaces of the boiler, and to accomplish that, if possible, by natural means, without the aid of any special machinery.

Mr. Young agreed with the last speaker as to the importance of keeping up a circulation in the water. It would be a good thing if they did away with the idea of steam and boiling, and viewed the engine simply as an apparatus for getting the greatest amount of heat from the fuel and applying it to the point where it was to be utilised, viz., the crank shaft. There were two great causes of waste in steam engines—imperfect combustion to generate the steam, and improper use of the steam when it was produced. As far as he had been able to follow Mr. Burgh, he believed that gentleman had arrived pretty nearly at the theoretic truth.

Mr. Burgh said it appeared to him that Mr. Wilson was inaccurate in his view of the cause of priming. In his plan the openings for the escape of the steam were much larger in the aggregate than in the ordinary plan, but the reason of the priming was that the tendency of the water was to follow the steam.

The Chairman said that one feature in the paper which had struck him was the importance which the writer attached to perfect combustion, for which purpose he proposed a large combustion-chamber, as shown in the diagram. He believed a plan had been introduced by Mr. Wye Williams for introducing small jets of air, so as to afford oxygen to the fire.

Mr. Burgh drew a figure on the board to represent the plan adopted by Mr. Williams, one feature of which was a very large combustion-chamber.

The Chairman said the principal feature he remembered in Mr. Williams' plan was the adoption of a large number of small holes or wire gauze, which, when opened, insured perfect combustion, but when closed the combustion was slower and more perfect. As in burning ordinary gas the hydrogen was ejected into the atmosphere, whence it drew the oxygen to support combustion, so in this plan the air containing the oxygen was injected into the mass of burning hydrogen. He knew of instances where it had answered admirably.

Mr. J. C. Wilson illustrated his view of the cause of priming by a diagram, in order to remove what he believed was a misunderstanding on the part of Mr. Burgh. In an ordinary boiler there was no circulation whatever, the steam being formed on the under surface next the fire under pressure, and when a valve was opened the rush of the steam towards the opening carried the water with it. In a marine boiler the principle was the same; the steam accumulated over the surface of all the tubes, and when the pressure was removed, or an opening made, it rushed towards it, carrying the water with it. If the valve were opened gradually the objection was removed, because the pressure was not at once taken off.

The Chairman said the fact was that if steam were allowed to acquire velocity, it carried the water with it, but not otherwise.

Mr. Varley, in connection with the question of utilizing all the heat given off from the fuel, mentioned one or two kinds of boilers in which, by means of small conical projections, a greater heating surface was presented to the water.

Mr. Teulon said he had been somewhat disappointed in the paper, which purported by its title to point out the principles that should govern the future development of marine boilers, engines, and screw propellers, whereas it was principally confined to a description of their present state. True, one point was incidentally stated as the direction in which improvement should take place, and that was to make furnaces which should ensure slow combustion; all who knew anything of the subject were aware that in proportion as the fuel was consumed at leisure (so to speak), the greater would be the effect from a given quantity of fuel. In marine boilers, however, from various circumstances, they had to solve the problem of getting the greatest possible effect in the smallest space, and it was in this direction, he believed, that they must look for improvement. They must remember that in marine boilers there was not the opportunity for almost unlimited fire space as in land boilers. He agreed with Mr. Wilson as to the cause of priming, which was somewhat similar to the familiar instance of drawing the cork of a soda water bottle.

Mr. Pearsall said that he had an opportunity, a few days after the action between the *Kearsage* and the *Alabama*, of inspecting the former vessel, the boilers of which seemed to be made on a different principle to any he had seen in England. The tubes were vertical instead of horizontal, and the fire was outside instead of inside them, and, as one consequence of that, there was a large chamber or firebox. The American engineers said they went on the same principle as the English of a large heating surface, but they reckoned that the outside of a tube was larger than the inside. They also considered that, amongst other practical advantages, the tubes were much more easily cleansed.

Mr. Young said that this kind of boiler, known as Martin's boiler, was the invention of Earl Dundonald, and had been used in a great many English ships, the *Chanticleer* amongst others. He did not know why they had not been more generally adopted.

Mr. Girdwood said the main point to be gained was a large number of lbs. of fuel consumed per square foot of fire-grate. The boiler occupied a certain space, and on the question of whether 17lbs., or 30lbs., or 40lbs. of coal per foot of fire-grate was consumed depended the results that the boiler would yield. The plan for preventing priming, which had been described by Mr. Burgh, seemed very reasonable; and, with 17lbs. or 18lbs. of coal per foot of grate, would, no doubt, answer very well, but with 30lbs. or 40lbs. it would be perfectly useless, for the water was converted into steam so quickly, and in so small a space, that it was forced forward into the engine.

Admiral Ommanney said that in vessels of war, the great point was to keep the boilers below the water-line, so as to be out of reach of the enemy's shot; he should like to know if this were so in in the *Kearsage*.

Mr. Pearsall said he understood that the boilers were protected by coal bunkers in the usual way, and by having chain cables passed up and down on either side.

Mr. Girdwood remarked that in some boilers he had had to do with, they had obtained from 300 to 400 horse-power by the consumption of 17 lbs. of coal per square foot, and $4\frac{1}{2}$ lbs. of coal per horse-power, and in the same boilers with the consumption of 30lbs. of coal per foot, it had been at the rate of $7\frac{1}{2}$lbs. per horse-power, and by this they obtained more than double the power.

The Chairman said he believed the question of putting the fire inside or outside of the tubes had been well considered in this country, and there were probably some good reasons why the former plan was universally adopted, at any rate in locomotive engines.

Mr. HANCOCK thought one of the great objections to having the water inside of the tubes, and the fire outside, was, that there was such small water space, and in case of failure of the feed-pump, the water so soon fell below the proper level. Besides, there would be much more effect from the inside of the tubes being at an exceedingly high temperature, and having the larger surface of the outside to radiate from, than if the reverse were the case. There was also great difficulty in cleaning the tubes when they got coated inside by deposit from the water. He agreed with Mr. Burgh in his views as to priming, but there were two different causes producing the same result. There was, first, the priming which arose from the sudden opening of a valve, and secondly, that which was occasioned by the ordinary uniform working of the boiler, and this latter arose from there not being sufficient steam space. In a stationary boiler that could be obviated by having the steam space larger, but in marine boilers there was not the same opportunity, and he agreed with Mr. Burgh that the most reasonable way of preventing this priming was by drawing the steam from as large an area as possible, in fact, from every portion of the boiler rather than from one opening of perhaps 12 inches diameter. He did not quite catch what Mr. Burgh said as to incrustation, which was a very important subject. The matter deposited generally consisted of carbonate and sulphate of lime, and the conducting power of such a deposit was much inferior to that of iron. He believed the only effectual remedy was surface condensation, and if the injurious effect of the acid with which the water was charged, from contact with the grease, &c., in the interior of the cylinder, could be prevented by the use of some composition, or by the admixture of a certain proportion of sea-water, then a great point indeed would be gained.

The CHAIRMAN remarked that there was one important practical question which had not been touched upon, viz., the mode of feeding the furnaces. A few days ago he had seen a plan, introduced by Mr. Lermit, for feeding furnace-fires from the bottom by means of an Archimedean screw, which produced the most perfect combustion. The same method had been used for some time with great success in domestic fireplaces and kitchen-ranges.

Mr. N. P. BURGH, in reply to the observations made in the discussion, said, in answer to Mr. Wilson, that he (Mr. Burgh) considered that gentleman's ideas of priming were decidedly erroneous in relation to marine boilers, for usually the tubes and fire-boxes were arranged especially with a view to the circulation of the water, as shown by the diagram No. 1, in Section A., and thus the fault which Mr. Wilson pointed out scarcely existed in practice. The arrangement of the hollow perforated chamber at the roof of the boiler, alluded to in the paper, obviated also any of the evils from priming beyond the boiler, so that the water could not follow the steam under any circumstances to an injurious extent, if at all. Another gentleman alluded to the sudden exit of the contents of a soda water bottle when the cork was withdrawn, as the best illustration of the cause of priming. Mr. Burgh considered there was not the least analogy between the two. He believed that Mr. Varley was in error with regard to projections on the plate conducting the heat more readily, because the reverse was the case, and, in fact, the thinner the plate, so long as it was strong enough, the less it became burned. Another gentleman had objected that he had not alluded to principles, but he thought he had alluded to the principles generally admitted by engineers, and as an engineer he could not do otherwise. As to slow combustion, it was perfectly plain that if there were a certain amount of heat in the fuel, sufficient time must be allowed for it to be extracted, or there would be a loss. He could not imagine how it could be supposed that tubes, placed as thickly together as they would go, could be cleaned more easily outside than in. The best mode of keeping boilers clean was a very important subject, and the plan he advocated was to mix a certain quantity of sea water with the condensed water, thus forming a thin coating on the interior, which prevented any galvanic action. It was possible to so regulate the quantity of sea water admitted as to make this scale of deposit as thin as possible. As to feeding the boiler, he thought if the Chairman were at sea he would say let the mode be as simple as possible, because if it got out of order they would be in an awkward position. In conclusion, he expressed disappointment that there had not been a more animated and detailed discussion.

The CHAIRMAN thought Mr. Burgh need not be disappointed, because the reason so little had been said probably was that most of the audience agreed with the principles laid down in the paper. Moreover, perhaps the most valuable portions of the paper were those which had been omitted in reading, viz., the tables, which could not be made intelligible orally to a general audience. There were, however, one or two points upon which, perhaps, more might have been said; for instance, on the question of superheated steam, in which the Americans certainly had taught us a great deal. Then there was the question of superheating water, bringing it almost to a white heat, so that it could be flashed into steam instantaneously. This he had seen, when quite a youth, adopted by Perkins. The condition of water as a means of absorbing heat, and the facility with which it could be managed compared with steam, rendered this question of great importance, and he believed it was in that direction that progress must be looked for. Perhaps the most interesting subject practically was that of slow combustion, as affected by the proportions of the combustion-chamber and the arrangements of the fire-grate. Although theoretically the principles were well understood, yet in practice the various conditions under which furnaces had to be constructed would always render it difficult to ensure perfect combustion, but he supposed everyone would agree that slow combustion was the main requisite. If the fuel could be introduced (as he had before observed) at the bottom of the fire, so that all the products should pass upwards through the fire, it would be a great end gained. The only question would be whether the apparatus, which in his own experience answered perfectly well for kitchen and other grates, might not, perhaps, be too cumbersome in the much larger form necessary for steam-boilers. In conclusion, he remarked on the valuable nature of the paper, some portions of which would probably become standards of reference, and he was sure the meeting would feel that the author was well entitled to their warmest thanks.

A vote of thanks was then passed to Mr. Burgh, and duly acknowledged

The paper was illustrated by some working models of marine engines, sectional and complete, kindly lent by Messrs. Maudslay, Sons, and Field, the Thames Ironworks Company, Messrs. Dudgeon, and Captain T. Symonds, R.N.; as well as by a steam-engine indicator from Messrs. Elliott, Brothers. A large working model of the valve-link motion was also shown.

Fine Arts.

SOUTH KENSINGTON MUSEUM.—Great changes are impending over this Museum. The iron portion of the building, which gave to the structure the name of "The Brompton Boilers," is about to be removed, and again set up on a site, already designated, at Bethnal-green, there to form an auxiliary Museum of Science and Art for the East of London. The sum of £5,000 was voted last session by Parliament "on account" of a total estimate of £20,000, to defray the cost of this auxiliary museum for East London. The entrance to the South Kensington Museum is now brought more towards the centre of the permanent structure. The

new permanent buildings at Kensington, on account of which the grant of £32,500 was made last session, continue in steady progress. The decorations of the portions already erected possess novelties as striking as the courts hitherto opened to the public. Various artists were invited to give their assistance in carrying out the ornamentation of the lecture theatre and the buildings connected therewith. The decorations of the refreshment rooms, commenced by the late Mr. Godfrey Sykes, have been, since his death, entrusted to his pupils, Messrs. Gamble and Townroe, to whom are also delegated the ornamentation of the corridors and the lecture theatre. The firm of Morris, Marshall, and Co., known for revivals of ancient processes and for efforts to bring art into novel relations to domestic uses, has been occupied in the adorning of the dining room. Mr. Poynter, the young artist who became conspicuous in the last Royal Academy by his large picture, "The Israelites in Egypt," has also been engaged upon these new buildings. Other of the mural decorations are from the designs of Mr. Moody; and Mr. W. B. Scott, a poet as well as an artist, has given drawings for the staircases leading to the lecture theatre. The external architecture of the principal quadrangle has for some time been open to view. Mr. Townroe has furnished the designs for the mosaic work, in terra cotta tesseræ, for the lunettes, panels, and pediments in the front of the building. For the present, the collection of naval models, transferred some time since from Somerset-house to Kensington for the use of the students of the School of Naval Architecture, has been re-arranged over the southern arcades of the gardens of the Royal Horticultural Society. There, also, in the interim, are located the collection of animal products, and the Museum of Construction. These several collections are now open to all visitors, subject to the same regulations as the central museum. The entrance is from the Exhibition-road, by the access to the recent National Portrait Galleries. To the above new developments must be added the rise of the building for the Schools of Naval Architecture and of Science in the Exhibition and Cromwell roads. The architecture and decorative details of the western façade of these schools will be similar to the style of the principal quadrangle. These schools will comprise spacious class-rooms, professors'-rooms, chemical and metallurgical laboratories, libraries, specimen museum, together with a central lecture-room. The general plan of the new buildings, as finally revised by Captain Fowke, and now in part erected, was published in the report of the Science and Art Department last year. In that report it is stated that "the outside decorations will be executed in flat tertiary tints; those in hand are limited to the colours of ochre, brown, and black; and it is believed they will be as imperishable as the best brickwork, and not likely to be degraded by the dirt in the atmosphere, which it is certain that glass mosaics, with their comparatively rough surfaces, would be." The relict of the late Dr. Woollaston has just presented to the art library of this museum a valuable series of drawings of Greek and Roman mosaics to be found in Spain, France, Pompeii, Prussia, Halicarnassus, Switzerland, Rome, and Italy generally, Constantinople, Carthage, and also in various counties of England, which had been executed for Dr. Woollaston.

Manufactures.

Silk Manufacture in Italy.—At one time Italy had almost the complete monopoly for the production of silk, and the cities of Lucca, Florence, Genoa, and Venice supplied the whole of Europe with silk goods, and derived great riches from the trade. The silk industry very soon spread into other countries, and there now remains to Italy but the supremacy in the production of her raw material, and which all the other countries in Europe have not been able to equal in quality. Before the spread of the disease among the silkworms the annual production of raw silk in Italy, exclusive of the Venetian provinces, amounted to £6,705,720 sterling. In 1863, the production of cocoons was 508,222 cwt., to the value of £4,200,000, with the expense of about £960,000 for grains. In 1864, the production of cocoons in Italy, exclusive of the Venetian provinces, was only 222,126 cwt., of the value of £2,480,000; and in 1865, the production was 222,020 cwt., amounting to the value of £2,860,000. The number of reeling establishments in Italy are 5,519, of which 394 are worked by steam, and produce about 40,000 cwt. of reeled raw silk, to the value of £5,264,422; on this amount it may be presumed that about £980,000 are the profits for the proprietors of the reeling establishments, not taking into consideration the waste (floss), which may be estimated at £210,000. The throwing-mills yield about 2,719,336 lbs. of tram and 3,268,533 lbs. of organzine, amounting to the value of £7,860,000. The manufacture of silk stuffs is limited to plain goods, which are carried on in 260 manufactories, giving employment to about 20,000 persons of various trades. The most important manufactories are those of Como and Genoa, whilst from England and France silk stuffs were imported into Italy, in 1863, to the amount of £859,920; in 1864, to the value of £812,320; and in 1865, for £805,360.

Commerce.

Irish Butter.—The following appeared in the *Times* of November 20th:—"The butter reform movement is progressing steadily in the south of Ireland. The farmers seem generally alive to the necessity of retrieving their character in the English markets, and are receiving in a docile spirit any practical suggestions which are offered to them. On Saturday, November 16th, a numerous meeting was held at Bandon, under the presidency of the Earl of Bandon, to consider the propriety of establishing a firkin butter market in that town. Mr. Shea exhibited an improved firkin, which he stated had elicited the approval of English merchants to whom he had shown it. The size was much smaller than the firkin previously in use, and it was more suitable for shopkeepers and housekeepers in England. It was wider at the bottom than at the top, so that it could be more easily cleaned, and could not be rolled about as the present firkins are, in consequence of which they accumulate dirt. He recommended a mild cure, and complained that Cork market was not an open one, where any person could buy or sell, but was subject to regulations made by a self-constituted body, called the committee of merchants. The farmer who sent in his butter was obliged to hand it over to them, and had no voice in fixing the price. He mentioned other facts, to show that the farmer laboured under peculiar disadvantages in sending his butter to the Cork market. He therefore advocated the establishment of a permanent butter market in Bandon, and recommended that the farmers should bring their butter in packages of 14lbs. instead of in rolls, as at present. Mr. Sullivan observed, that when butter was selling at 20d. in London, and only 8d. or 10d. in Bandon, there must be something wrong. A committee was finally appointed to consider the matter, and report to a future meeting."

Colonies.

Queensland Sugar.—Some recent sales of Queensland sugars were effected at prices varying from £29 to £34 per ton. Each consignment was good of its kind, and the question of the capability of this colony to grow sugar cane and manufacture therefrom superior sugar, seems for ever put at rest. It has long been known that it

could grow the cane, it is now proved that the cane will yield sugar in a degree and quality not inferior to the cane of any other country. The impetus this fact is giving to agriculture is very marked. On all the rivers near the present sugar mills, considerable breadths of land are being brought under cane. A meeting of farmers was to be held on the Logan to make arrangements for the growth of the cane, with a view to the erection of a mill on that river. "There is in the cultivation of sugar cane here," says a Queensland paper, "the most inviting opening for British farmers of moderate capital. There are few places where an enterprising farmer with £1,000, or even less, can find a brighter prospect before him than by settling down in the neighbourhood of one of the sugar mills and turning planter. The growth of the cane is by no means more difficult than that of mangolds, while the variations of the climate affect this crop almost less than any other."

Notes.

Utilisation of the Sewage.—It appears by the report of the Metropolitan Board of Works that in reference to the company to whom the concession of the northern sewage was granted, their results on 210 acres of sand and poor land to which sewage was applied, have been most satisfactory. The crops which have been raised from land manured with sewage have exceeded the most sanguine expectations. The principal crop grown is Italian rye-grass; and it is stated that on one piece which was sown in August, 1866, and which has received about 4,000 tons of sewage per acre, the crops were as follows:—Eight tons per acre early in April, 10 tons in the middle of May, and about 12 tons in the week ending 22nd of June. On other pieces the crops were even heavier. It also appears that great success has attended the growth of mangolds, potatoes, flax, lucerne, cabbage, celery, and strawberries. The most promising experiment, however, was the wheat crop, on which the sewage was poured four times during the early growth of the crops.

Railway Across the Col de Tenda.—A memorial has lately been presented by the Chamber of Commerce of Cuneo to the Minister of Public Works at Florence, urging him to bring before Parliament the project of connecting Cuneo and Nice by way of the Col de Tenda, passing by Ventimiglia, when it would join the littoral line. A branch line is proposed to be constructed from Cuneo, passing through Mondovi to Ceva, when it would join the partly constructed Turin and Savona Railway. This line would put Turin in communication with two fresh sea-ports, Savona and Ventimiglia, and would connect the towns of Northern Italy with Marseilles.

Correspondence.

Industrial and Scientific Education. — Sir, — I have seldom more keenly felt the infirmity of my chest, which prevents me from raising my voice at a public meeting, than I did on the evening of the 11th inst., when I was thus debarred from acknowledging the courteous manner in which Mr. Davidson was pleased to mention my humble exertions, and from endeavouring to afford him that support which his able advocacy of industrial instruction entitled him to claim from those who had devoted some amount of attention to this important subject. It was some consolation to perceive that, among the arguments opposed to him, few were of a nature to carry much weight with them, whilst several served rather to supply additional evidence of the great truths with which he had endeavoured to impress his audience. I had intended touching on a few of those arguments in the present letter, but I feel that this has been rendered superfluous by the publication in the Society's *Journal*, of Mr. Wallis's supplement to the debate, and of Mr. Smiles's admirable discourse at the Huddersfield Mechanics' Institute. Documents like these, following as they do on the powerful expressions of opinion at the late meeting of the Associated Chambers of Commerce, and backed as they soon will be by the testimony of the working men sent over by the Society to study industry and its training at Paris, cannot fail to prepare our members at large for an earnest consideration of the great questions to be discussed at our intended January Conference, and for an intelligent appreciation of the opinions which we may then expect to hear pronounced by some of the most competent men of the day. It is to be hoped that on that important occasion, the governing principle will not be to select contested points, for the sake of argument, but to adopt at once, in a conciliatory spirit, those upon which all are agreed, and, taking these as a base of operations, to unite cordially in putting the shoulder to the wheel. Among the important points on which those who have devoted special study to the requirements of our national industry, and even those who have merely perused with attention the evidence given in the pages of our *Journal*, can scarcely fail to be of one mind, are the following:—1. "Knowledge," as Professor Tyndall appropriately reminds us, "is power;" and in the long run, cleverness guided by routine must yield the palm to cleverness guided by brains. 2. Setting aside divergent opinions as to the rank which English manufacturers might have occupied at the late Paris Exhibition, if they had been so inclined, it is an undeniable fact that foreign competition is making successful inroads into markets where we have long reigned supreme. 3. Allowing the rapid progress of foreign manufacturers in branches of industry which we have been accustomed to call our own, to have been greatly due to the distance at which they were behind us, and to the advantage of copying models so perfect as those we provided them with, yet it is within probability that this progress, promoted by every advantage which a well-organised educational system can afford, will continue whether we go ahead or not. 4. Again, whilst we duly recognise in our working men qualities which defy competition on equal ground, we must take into account, at the same time, the advantages possessed by continental industry in the cheaper rates of most of the necessaries of life, to say nothing of the greater ingenuity displayed in economising them. 5. Without calling in question the suitableness of our present plan of elementary education for effecting the purpose had in view by those who established it, we may confess that it is neither sufficiently broad in principle, nor sufficiently extended in its sphere of action, to form the groundwork of a national system of industrial training. 6. The present apprenticeship system, whilst it presents too many valuable points, and is too popular to be superseded, requires a thorough and careful revision. 7. The establishment of a satisfactory national system of industrial training, will involve much beyond what the best organised apprenticeship can be expected to realise. It will require in addition a responsible centralised agency, supported by the patriotic efforts of all classes of the community, and especially of all existing institutions, or bodies having a bearing in this direction. 8. The great advance in art-industry, which we owe to the efficient system of art-training organised under the direction of Mr. Cole, sufficiently indicates what might be expected from a similar manifestation of government activity, differing, of course, in plan according to the difference of purpose, but conducted with equal intelligence and energy. 9. Good local results might be expected from a liberal co-operation on the part of the respective guilds and trades' corporations. 10. Though no foreign educational system is likely to suit, *in toto*, the wants and notions

of this country, nor any institutions susceptible of being introduced, without considerable modifications, yet there can be no doubt that, by studying foreign systems and institutions with a willing mind, we may derive from them many a valuable hint, and gain wisdom from borrowed experience. I feel confident that great practical benefit may be expected from so opportune a gathering of eminent and special men as that to which we are now looking forward, provided well-trodden ground be not trodden over again, and a certain number of fundamental points, such as the foregoing, can be agreed upon, *in limine*, as being sufficiently elucidated by the evidence already published, and sufficiently accepted by general consent; so that the brief appointed period of three days may be devoted to actual progress in the elaboration of what may be termed the "ways and means" of industrial training.—I am, &c., T. Twining.

Twickenham, 17th Dec., 1867.

MEETINGS FOR THE ENSUING WEEK.

Thur ...Royal Inst., 3. Prof. Tyndall, "Heat and Cold" (Juvenile Lectures.)
Mathematical, 8.
Fri.......Quekett Microscopical Club, 8.
Sat ......Royal Inst., 3. Prof. Tyndall, "Heat and Cold." (Juvenile Lectures.)

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Par. Numb. *Delivered on 4th December*, 1867.

20. Bill—Totnes, &c., Writs.
19. Halifax, Bermuda, and St. Thomas Packet Service Contract.
North America (No. 2, 1867)—Further Correspondence.
Abyssinia—Return of Names of Prisoners, &c.
Foreign Office—Names of Clerks who act as agents for Officers holding Diplomatic or Consular Appointments.
Public Petitions—Second Report.

Delivered on 5th December, 1867.

21. Bill—Church Rates Abolition.
23. „ Railway and Gas Shares.

Session 1867.

238. Criminal Offenders (Scotland)—Corrected Pages.

Delivered on 7th December, 1867.

1. Bill—Artisans and Labourers' Dwellings.
9. „ Turnpike Trusts.
10. „ Church Rates Commutation.
19. „ Life Policies Nomination.
21. Metropolitan Public Schools—Letter from Mr. Ayrton.
30. Carlow Lunatic Asylum—Correspondence.
Private Bills (Session 1867-8)—Statement.

Session 1867.

579. Poor Relief (Metropolis)—Return.

Patents.

From Commissioners of Patents' Journal, December 13.

Grants of Provisional Protection.

Aprons, bibs, &c.—3170—S. Simon.
Bark, &c., making extracts from—3358—A. V. Newton.
Barrels, facilitating the flow of liquids from—3367—R. H. Bentham.
Bedsteads—3383—J. R. Towers.
Bells—3416—C. Hargrove and S. Hargrove, jun.
Bones, &c., grinding—3393—J. H. Johnson.
Boots, &c., folding and pressing the edges of elastics used in—3375—E. T. Hughes.
Braces—3446—J. Sanders.
Brake-washers—3399—W. E. Gedge.
Bricks, hollow—3377—J. H. Johnson.
Buckets, &c., handles for—3418—J. H. Dean.
Buildings, metallic, &c.—3428—R. Porter.
Buildings, &c., ventilating—3361—J. S. Smith.
Buildings, &c., ventilating—3397—J. J. Parkes.
Cables, paying out, &c.—3390—M. F. Maury.
Cannons, tubular—3241—E. Farrington.
Casks, metallic—3450—R. R. Gray.
Chronometers—3396—A. M. Clark.
Cloth, &c., dyeing—3419—W. Schofield.
Clothes, washing—3395—A. V. Newton.
Cotton seed, obtaining oil from—3388—T. Rose and R. E. Gibson.
Cotton, &c., apparatus for preparing—3338—H. Greenhalgh.
Digging machines—3199—J. T. B. Porter.
Earthenware, constructing articles of—3380—J. R. Pratt.
Engines, steam—3379—E. Wood.
Fabrics, clamping and stretching woven—3454—F. Jolly.
Fabrics, cutting—3372—W. Cotton.
Fabrics, &c., boiling and washing—3385—W. R. Lake.
Fabrics, &c., drying and stretching woven—3401—T. Briggs, jun.
Fish-hooks, manufacturing—2479—A. Fenton and J. Sandilands.
Food for children, &c., warming—3310—T. G. F. Dolby.
Fuel, &c., drying artificial—3420—D. Barker.
Gas, regulating the supply to burners—3415—E. Price.
Globes and glasses—3404—S. E. T. Steane.
Grain, decorticating and drying—3424—J. Hadley.
Horses' bits and stirrups—3438—H. F. Gardner.
Horses' shoes—3368—W. Palmer.
Lace—3444—F. R. Ensor.
Lace, &c., ornamenting—3452—F. B. Baker and L. Lindley.
Lamps, miners' safety—3376—T. S. Horn.
Magnesia, preparing sulphate of—3389—C. Albisser.
Matches—3336—R. M. Letchford.
Meat, preserving—3323—W. Mort.
Metal cases, &c., opening—3365—M. A. Hamilton.
Meteorological instruments—3335—W. F. Stanley.
Motive-power apparatus—3402—W. Starkey.
Neck-ties, &c., fasteners for—2723—T. and O. Vaughton.
Oils, utilising mineral and other—3434—J. G. Hope.
Presses, hydraulic—3392—W. C. Houghton.
Printing machinery—3387—J. Fraser and G. Duncan.
Railway carriages, &c.—3398—W. E. Gedge.
Railway waggons, couplings for—3407—R. F. Compton.
Rocks, &c., cutting—3311—A. Munro.
Saccharine solutions, clarifying—3405—W. R. Lake.
Seeds, separating and cleaning—3373—T. Rose and R. E. Gibson.
Ships' signals—3391—H. S. Cowan.
Snow and ice, melting—3456—J. F. Clarke.
Sofas, &c.—3412—T. F. Widenham and J. Reynolds.
Spinning machinery—3411—W. Priestley and W. Bower.
Sprinklers for powdered substances—3374—E. T. Hughes.
Steel, &c., manufacturing cast—3440—J. Gjers.
Steel, &c., moulds for casting—3400—R. McClure.
Stone, cutting—3354—C. Coates.
Sugar, manufacturing—3417—W. R. Lake.
Tables, &c., mechanism for expanding—3410—J. Fitter.
Tea and coffee pots—3370—E. T. Hughes.
Telegraph posts—3406—S. Sharrock.
Telegraphs—2909—W. R. Lake.
Telegraphs—3317—E. T. Hughes.
Tobacco pouches, &c.—3197—R. P. Faucheux.
Tramways—3291—L. B. Joseph.
Type composing and distributing machines—3366—A. Mackie.
Umbrellas—3442—W. Sangster.
Umbrellas, &c.—3382—J. Scholefield.
Unguents, preserving—3378—J. M. Napier.
Warp ends, joining—3177—J. H. W. and A. W. Biggs.
Warp ends, joining—3426—J. H. W. Biggs.
Water-closets, &c.—3430—J. H. Wilson.
Water-meters and water-power engines—3369—M. H. and L. H. Larmuth.
Wool, &c., preparing—3371—T. and B. Carter and J. Lisle.

Invention with Complete Specification Filed.

Railway and other tickets, dating—3465—J. Adams.

Patents Sealed.

1403. A. Clark.	1773. W. Cooke.
1748. G. McKenzie.	1774. D. Sowden & R.C. Stephenson.
1750. R. Beard.	1775. Sir T. Tancred.
1754. C. Erba.	1777. W. Fairley.
1755. C. and S. A. Varley.	1781. J. Edwards.
1759. R. W. Barnes.	1783. J. G. Jones.
1765. J. Welch.	1807. W. Clarke.
1769. G. T. Bousfield.	1894. J. G. Tongue.
1770. M. Gray.	2212. J. M. Hocking.
1771. M. Gray and L. Gibson.	2745. T. Prideaux.
1772. M. Gray.	

From Commissioners of Patents' Journal, December 17.

Patents Sealed.

1786. D. Jones.	1837. E. P. Gleason.
1788. L. Simon.	1839. W. E. Newton.
1790. J. Coppard.	1846. T. Crow.
1793. H. C. Hurry.	1849. A. Aitchison and T. South.
1795. J. H. Johnson.	1851. W. T. Watts and D. J. Fleetwood.
1797. D. Jones.	
1803. H. K. York.	1936. H. Davey and D. Davy.
1804. H. G. B. Röber.	1944. D. Davy.
1819. G. Dickie.	1949. W. E. Newton.
1821. F. Reddicliffe.	2611. C. Holste.
1830. S. Hall and W. H. Parsons.	2975. C. D. Abel.

Patents on which the Stamp Duty of £50 has been Paid.

3137. Z. Eastman.	3108. J. A. Pols.
3083. C. Kendall.	3130. B. Dobson, W. Slater, and R. Halliwell.
3103. C. P. Coles.	
3105. J. and J. Leeming and J. Lister.	3126. J. L. Norton and W. Ainsworth.
3099. G. W. Belding and D. E. Holman.	3160. H. Bird.

Patents on which the Stamp Duty of £100 has been Paid.

3027. R. Davison.	3086. G. Davies.
3085. G. Davies.	